

NASA-CR-163728 19810003(€2

A Reproduced Copy of

NASA CR-163, 728

LIBRARY COPY

APR 2 9 1981

LANGLEY RESEARCH CENTER LIBRARY, NASA HAMPTON, VIRGINIA

Reproduced for NASA by the

NASA Scientific and Technical Information Facility



COSMIC

A Catalog of Selected Computer Programs

(NASA-CR-163728) COSMIC: A CATALOG OF SELECTED COMPUTER PROGRAMS (Georgia Univ.) 150 p HC A07/HF A01 CSCL 09B

1181-11690

Unclas G3/61 37926

National Aeronautics and Space Administration

N81-11690#

Availability of Programs described in this Catalog

Programs described in this catalog may be obtained from the Computer Software Management and Information Center (COSMIC), 112 Barrow Hall, University of Georgia, Athens, Georgia, 30602, Telephone (404) 542-3265.

Additional Programs

This catalog contains only a sample of the over 1,500 programs in the COSMIC inventory. If you do not see the program you need in the catalog, contact a COSMIC representative directly to determine if there is a program to fit your needs.

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights.

PUBLISHED BY:

-National Aeronautics & Space Administration Technology Utilization Office

Foreword

The Computer Software Management and Information Center (COSMIC) is operated for NASA by the University of Georgia for the purpose of making computer programs developed in the space program available to the public. Many programs from the Department of Defense and selected software from other government agencies are also offered. At present, over 1500 programs in almost every technical or managerial discipline are available. This catalog describes about 300 of the programs for which most requests have been received.

Before offering a program for sale, COSMIC ascertains that it will compile and that the documentation describing it is adequate. Then a brief description is written for inclusion in Computer Program Abstracts, which is the complete catalog of software that is available (for ordering details, contact COSMIC). Especially useful programs are also described in NASA Tech Briefs, a free quarterly publication containing about 150 articles on NASA innovations of all types thought to have commercial application. To get on the mailing list for Tech Briefs, write NASA, Code KT, Washington, DC 20546.

Another important, and free, service offered by COSMIC is the identification of potentially useful software for customers who are unable to find what they need in the catalog. Simply call or write COSMIC to obtain assistance. Also, in some cases NASA engineers can offer guidance to users in installing or running a program when difficulties are encountered.

The prices charged by COSMIC are established in accordance with NASA policy to recover as large a portion of COSMIC's operating expenses as possible, without making programs prohibitively expensive for small firms. In actual practice, NASA subsidizes about one third of the cost of the services

provided by COSMIC.

COSMIC is eager to help you save money by using software for which the development expenses have already been paid. For more information about services or software available from COSMIC, call or write:

> COSMIC 112 Barrow Hall The University of Georgia Athens, Georgia, 30602 Telephone: (404) 542-3265

TABLE OF CONTENTS

Section	Page
AERODYNAMICS	1
AIRCRAFT	7
AUXILIARY SYSTEMS	11
BIOTECHNOLOGY	13
CHEMISTRY	17
COMPUTERS	19
ELECTRONICS	31
FACILITIES, RESEARCH AND SUPPORT	37
FLUID MECHANICS	47
GEOPHYSICS	51
INSTRUMENTATION AND PHOTOGRAPHY	55
MACHINE ELEMENTS AND PROCESSES	59
MATHEMATICS	65
STRUCTURAL MECHANICS	77
THERMODYNAMICS AND COMBUSTION	91
AERODYNAMICS	
(Includes Aerodynamics of Bodies, Wings, Rotors, and Control Surfaces; Internal Flo Ducts and Turbomachinery)	ow in
LAR-11047 — Vortex-Lattice FORTRAN Program for Estimating Subsonic Aero- dynamic Characteristics of Complex Planforms	1
LAR-11197 — Computer Program to Determine Pressure Distribution and Forces on Blunt Bodies of Revolution	1
EAR-11305 — An Improved Method for the Aerodynamic Analysis of Wing-Body- Tail Configurations in Subsonic and Supersonic Flow	2
LAR-11573 — Modified Multhopp Lifting Surface Method of Aero Characteristics LAR-11663 — A Computer Program for Calculating Inviscid, Adiabatic Flow About Blunt Bodies Traveling at Supersonic and Hypersonic Speeds a Angle of Attack	2 · t 2
LAR-11727 — Subsonic Annular Wing Theory with Application to Flow About Nacelles	ł 2
LEW-00235 Computer Program for Calculating Flow Distribution in a Radia Inflow Turbine	1 .3
LEW-10471 — Computer Program for Analysis of Geometry and Design Point Performance of Axial Flow Turbines	t 3
LEW-10743 — FORTRAN Program for Calculating Velocities and Streamlines or a Blade to Blade Stream Surface of a Tandem Blade Turbomachine	3
LEW-10764 — Fortran IV Program to Estimate the Off Design Performance of Radial Inflow Turbines	3
LEW-10765 — Computer Programs for Axial Flow Compressor Design LEW-10788 — Turble-Fortran Program for Calculating Velocities and Streamlines	3
on a Blade-to-Blade Stream Surface of a Turbomachine LEW-10789 — Magnify-Fortran Program for Calculating Velocities in a Magnified Region on a Blade to Blade Surface of a Turbomachine	
Region on a Blade to Blade Surface of a Turbomachine LEW-10977 — Tsonic-Fortran Program for Calculating Transonic Velocities on a Blade Stream Surface of a Turbomachine	a 4

LEW-11029 — Analysis of Geometry	and Design Point Performance of Axiat Flow 4
LEW-11635 — Fortran Program for Q	hed Mendional Velocity Gradients uasi-Three Dimensional Calculation of Surface 5 g Flow for Turbomachine Blade Rows
LEW-11796 — FORTRAN Program for of a Turbomachine	Calculating Velocities in the Mendional Plane 5
LEW-11815 — Computer Program to Turbines	r Preliminary Design Analysis of Axial Flow 5
	or Calculating Potential Flow in Propulsion 5
	Definition of Transonic Axial-Flow Compressor 6
MSC-19493 — Stanton Number-Aeroc	lynamic Heating 6
	AIRCRAFT
(Includes Aircraft Design, Testing, and getion; Aircraft Instrumentation, Airc Control)	Performance: Aircraft Communication and Navi- raft Propulsion Systems; Aircraft Stability and
LAR-11013 — Prediction of Stall Ch LAR-11249 — Theoretical Prediction	and Contour Estimation Computer Program aracteristics of Straight Wing Aircraft of Interference Loading on Aircraft 7 of Interference Loading on Aircraft Stores 8
	or Design of Expansion Chamber Mufflers with 8 stational Heliconter
	r Design Point Performance of Turbojet and 8
LEW-11389 — Analysis of Jet Engine LEW-11516 — Computer Programs	
	or Handling Propulsion System Noise Data 9
AUXIL	IARY SYSTEMS
	n as Chemical Power Units, Fission Electric Cells, cs. Electric Generators, and Solar Power Units; matic and Electrical Systems)
a Mobile Gas Cooled	
BIO	ECHNOLOGY
(Includes Life Support Systems: Biod telemetry, Cardiography, Electroenceph Maintenance (Medicall)	ingineering (Bioinstrumentation, Biometrics, Bio- lalography); Personnel Training, Evaluation, and
COS-02450 Veterans - Administrati	on Automated ECG Analysis System, CDC 13
3000 Series Version COS-02451 — Veterans Administration	on Automated ECG Analysis System, Varian 13
3000 Series Version COS-02451 — Veterans Administrati 73 Version GSC-11540 — MIMS-Medical Inform; LAR-11802 — Proton Tissue Dose for	ition Management System 13 the Blood Ferming Organ in Human Geome 14
3000 Series Version COS-02451 — Veterans Administrative 73 Version GSC-11540 — MIMS-Medical Information 15 Version LAR-11802 — Preton Tissue Dose for try: Isotropic Radiation MFS-21237 — Metabolic Balance An MSC-14386 — VECTAN II: A Comput	ation Management System 13 the Blood Forming Organ in Human Geome-
3000 Series Version COS-02451 — Veterans Administration 73 Version GSC-11540 — MIMS-Medical Information LAR-11802 — Preton Tissue Dose for try: Isotropic Radiatro MFS-21237 — Metabolic Balance An	tion Management System 13 the Blood Forming Organ in Human Geome- alysis Program 14 er Program for the Analysis of Vectorcardio-
3000 Series Version COS-02451 — Veterans Administrative T3 Version GSC-11540 — MIMS-Medical Information Tissue Dase for try: Isotropic Radiatric MFS-21237 — Metabolic Balance An MSC-14386 — VECTAN II: A Computer Frams NPO-13205 — Nutritional Evaluation	thion Management System 13 the Blood Forming Organ in Human Geome- alysis Program 14 er Program for the Analysis of Vectorcardio- 14
3000 Series Version COS-02451 — Veterans Administrativa T3 Version GSC-11540 — MIMS-Medical Information Proton Tissue Dose for try: Isotropic Radiation MFS-21237 — Metabolic Balance Ant MSC-14386 — VECTAN II: A Comput grams NPO-13205 — Nutritional Evaluation	ation Management System 114 125 136 146 137 138 147 147 157 158 158 158 158 158 158 158 158 158 158
3000 Series Version Veterans Administrative 73 Version GSC-11540 — MIMS Medical Informs LAR-11802 — Proton Tissue Dose for try: Isotropic Radiatros MFS-21237 — Metabolic Balance An MSC-14386 — VECTAN II: A Computerans NPO-13205 — Nutritional Evaluation C (Includes Chemical Analysis and Ident Inorganic and Physical Chemistry)	ation Management System 13 Ithe Blood Forming Organ in Human Geome- alysis Program 14 er Program for the Analysis of Vectorcardio- of Diets 15 HEMISTRY Incation, Chemical Engineering, Electrechemistry, Ititative Analysis of Low Resolution Mass 17

LEW-11467 — General Chemical Kinetics Computer Program for Static and Flow	17
Reactions with Application to Combustion and Shock Tube Kinetics	
LEW-11722 — ACE-Aerotherm Chemical Equilibrium Computer Program	18
LEW-11740 — Computer Program for Calculation of Complex Chemical Equilibrium	18
Compositions, Rocket Performance, Incident and Reflected Shocks,	
and Chapman-Jouguet Detonations	
NPO-11950 — Three Bit Mass Spectral Search Program	18

COMPUTERS

(Includes Programs and Systems Designed to Manage, Evaluate, and Effect Control of the Operations of Hardware Resources; Systems for the Design, Implementation, Processing, and Monitoring of Software Resources; General Systems for the Management of User Data Including Information Searches and Retrieval and Graphics Support Packages)

COS-02210 — FLOW-CHARTER, A Program for Producing Flow Charts of FORTRAN	19
Source Docks, IBM-360 Version	
COS-02241 SLACMON-SLAC Software Monitor, Version 2.2 COS-02251 PROGLOOK-SLAC Program Performance Monitor	19
COS-02251 — PROSECOR-SEAC Program Performance Monitor	20
COS 02480 — BIBSYS-Bibliographic System	20 20
COS-02510 — Fortran Analyzer	20
COS-02520 — EXTRAN-Expression Translator	E1
DOD-00017 - NIPS-National Military Command Information Processing System,	21
System 360 Formatted File System	
DOD-00038 — General Purpose Overlay Loader for CDC 6000 Series Computers	22 22 22 22 22 22 22 23 23
GSC-11330 — S 350 AUTOFLOW Preprocessor System (SDS-900 Series)	22
GSC-11331 — S 360 AUTOFLOW Preprocessor System (DDP-24, 124, or 224)	22
GSC-11332 — S 360 AUTOFLOW Preprocessor System (CDC 3000L Series)	22
GSC-11333 — S 350 AUTOFLOW Preprocessor System (Univac 1100 Series)	22
GSC-11393 — FORTAP-FORTRAN Tape Conversion Package	22
GSC-11545 — Source Deck Compression and Update Program	22
GSC-11612 — SGINDEX-OS 360-System Generation Cross Reference Index	23
GSC-11787 — CSS-Character String Scanner	23
GCS-11933 — STRCMACS-OS 350 Assembly Language Structured Programming	23
Macros	
GSC-11952 — Library Documentation System	23
HQN-10426 — BCMRET-Bellcomm Information Retrieval System	24
HQN-10651 — PLTCON-Contour Plotting Program	24
HQN-10599 - RECON STIMS-Remote Console and Scientific and Technical Infor-	24
mation Modular System	
KSC-10450 — FFCPI-Fortran Flow Chart Program	24
KSC-10619 — ADMIS-Automated Data Management Information System	- 25
KSC-10778 — Multiple Utility Computer Program	24 25 25 25 25 26 26
KSC-10337 — RFI-Remote File Inquiry System	25
LAR-16372 — Generalized Digital Contouring Program	25
LAR-10959 — CODER-Common Generation Program	25
LAR-10990 — DOC-Automatic Documentation Computer Program	20
LAR-11124 — ALTLIB-Automatic Computer Subprogram Selection from Application	26
Frogram Libraries	20
	26
LAR-11324 — ODINEX-Executive Computer Program for Linking Independent Com-	20
puter Programs	27
LAR-11414 — BLKIO-An I O Buffering Scheme with Skipping Capability	
LAR-11693 — Program for Interfacing a H-P Model 9830 Calculator with a H-P	27
Model B Multichannel Analyzer	22
LEW-10857 — FORTRAN IV-Subroutines for Generating Printed Plots	27
LEW-10482 — PLOT3D-A Package of FORTRAN Subprograms to Draw Three	27
Dimensional Surfaces	
MFS-15107 — Algorithm for Reducing the Number of Required Points in a Graph-	27
ical Data Set	••
MFS-18725 — OSAM-Variable Length Input Output Routine	28
MFS-22536 MIRADS Marshall Information Retrieval and Display System	28
MFS-22633 — Computer Utilization Prediction Nodel	28
MFS-24360 Merge and or Modify Tabular Data Computer Program	28
MSC-14161 — FORTRAN Read Package	9
MSC-14815 — Hewlett-Packard 65 Emulator	29
MSC-17434 — CONSTAT-A Program for Concordances and Statistics	29
MSC-17557 — CHANCE-FORTRAN IV Digital Program Change	29
MSC-19423 — Indices and Cross References from Computer Readable Text	28 .9 29 29 29 29 30
MSC-19460 — 3D Plotting Program. HP 9820A	30
NPO-10127 Contour Plotting, FORTRAN IV Subroutines	30
NPO-13652 — SFTRAN-Structured Programming to Fortran Translator	30
WLP-10030 FLOWCHARTER-Program for Producing Flow Charts of Fortran Source	30
Source Decks, GE-635 Version	

ELECTRONICS

(Includes Electronic Circuit Design and Analysis; Design and Development of Basic Electrical and Electronic Components; Feedback and Control Theory)

ARC-10616 — VASP-Variable Dimension Automatic Synthesis Program	31
GSC-11526 — AUTOWIRE-IBM-360 Version	31 32
GSC-11947 — Puzzle-Computer Aided Design	32
GSC-11948 — AUTOSKEM I Automatic Electronic Schematics Program	32
HQN-10305 — SEE-Systems Effectiveness Evaluation Computer Program	32
LAR-11125 — ASAP-Automated Staistical Analysis Program	32 32
LAR-11184 — STICAP-Linear Circuit Analysis Program with Stiff Systems Capa-	33
bility	
LAR-11210 — Design of Microstrip Components by Computer	33
LEW-11749 — Computerized Technique for Documenting Complex Wiring	33
MFS.13094 — ECAP-Electronic Circuit Analysis Program (IBM 360 Version)	34
LEW-10567 — ECAP-Electronic Circuit Analysis Program (CDC Version)	34 34 34
NPO-11412 — ECAP-Electronic Circuit Analysis Program (UNIVAC Version)	34
MFS-15002 CIRCUS A Digital Computer Program for Transient Analysis of	3.5
Electronic Circuits	
MFS.15045 — MPP Control Program to Determine Minimum Phase from Variable	34
Gain Characteristics	
MFS-22401 — Computerized Logic Design of Digital Circuits	34
MSC-17487 — Telerance Analysis Program	35
NPO-11382 — Wire Chain Program, UNIVAC-1108 Version	35 35 35
NPO-11494 MTRAC Computer Program for Analysis of Circuits Including Mag-	35
netic Cores	

FACILITIES, RESEARCH AND SUPPORT

(Includes Simulators and Simulation Methods; Test Facility and Test Equipment Design and Operation; Cost Effectiveness, Examination and Selection of Equipment, Materials, Personnel, and Methods for Optimum Performance of Tasks; Support Facility Administration, Management and Inventory Control)

LEW-12505 — Digital Program for Solving the Linear Stochastic Optimal Control	37
ARC-10942 — Magnetic Tape Library System	37
COS-02390 — CPM Critical Path Method Computer Program	38
DOD 00037 - NGPSS NADC General Purpose Simulation System for CDC 6600	38
Series Computers	
GSC 10909 — CANS Computer Assisted Network Scheduling System	33
GSC-11512 — GREMEX-Goddard Research and Engineering Management Exercise	33
Simulation System	
GSC-11641 GEMS-Generalized Evaluation Model Simulator	39
GSC-11652 — CALICO Capital Assets Location Inventory Control	39
KSC-16805 — Booing Computerized Preventative Maintenance Program	39
KSC-10319 — Logistics, Hardware and Services Control System	39
LAR-11837 — LRC NASA PERT III	40
MFS-18141 — LABCON-Laboratory Job Control Program	40
MFS-15691 — Network Path Program	40
MFS-19040 — Special Program for Discounted Case Flow Rate of Return	40
Evaluation	
MFS-21477 — MIS-Manpower Management Information System	41
MFS-21478 — Vehicle and Equipment Operations Management Program	41
MFS 21669 — Job Resource Optimization Monitor for Project Management System	41
(PMS) Programs	
MFS-21670 — Job Resource Allocation, GPSS Model	41
MFS-21701 — MARVES-Marshall Vehicle Engineering Similation System	42
MFS-21873 — FAA Balanced Field Length, Critical Engine Failure Speed, and	42
Landing Distance Computer Programs	
MES-22672 — MARSYAS-Marshall System for Aerospace Simulation	43
MFS-22997 — A Computerized Solution of the Repner-Tregoe Method Algorithm	43
MFS-23073 — RETANN-MSFC Estimated Retirement Annuity Calculation Program	43
MFS-24321 — Engineering Critical Components Listing	43
MSC-17122 — Plant Services Recall System	43
MSC-17446 — Failure Mode and Effects Analysis Frogram (FMEA)	43
MSC-17451 — Record of Task Progress	43
MSC-17556 — Cost Information Management Computer Program	44
MSC-19116 — Logistics Resupply Computer Program	4,4
NPO-11973 Manpower Accounting Program	/4
NPO-13522 Morgantown Mass Transit Simulation Model	44
NPO-13834 — Minority Business Capabilities File	44
NUC-10213 — TIMER-A Tree-Like Task and Time Record System	45

FLUID MECHANICS

furbulence)	.5 2110
GSC-12009 — MULTIWICK: A Computer Program that Numerically Integrates the Differential Equations that Describe the Hydrodynamics of a Large Class of Heat Pipes	47
LAR-10990 — Compressible Laminar or Turbulent Nonsimilar Boundary Layers Computer Program	48
LAP.11018 - Program to Detarming Padiating Nonavigabatic Invised Flow Over	48
a Blunt Body by the Method of Integral Relations LEW-11415 — Numerical Solution of the Unsteady Navier-Stokes Equations LEW-11859 — CFNA-Compressible Flow Network Analysis Computer Program LEW-12286 — Computer Program for Quasi-One-Dimensional Compressible Flow with Area Change and Friction for Application to Gas Film Seals	48 48 , 49
LEW-12326 — Calculation of Supersonic Stream Parameters of a Real Gas from Measurable Quantities	49
MFS-00443 — Solution of Compressible Flows in Piping Systems MFS-14683 — Compressible Flow Computer Program MFS-21955 — KALV-Water Landing Loads Analysis	49 49
MFS-24172 — Computer Program for Pressure Drop and Pumping Power for Fluid Flow through Round Tubes	49 50
MSC-17566 — SMAC-Simplified Marker and Cell Method for Calculating Incompressible Fluid Flows	. 50
MSC-19178 — DUCT-Adiabatic Compressible Flow Duct Analysis Program NPO-10895 — Numerical Solution of Transonic Flow in a Convergent-Divergent Nozzle	50 50
NUC-10376 — Computer Program for Analyzing Piping Systems	50
GEOPHYSICS	
Includes Aeronomy: Upper and Lower Atmosphere Studies: Oceanography: Cartog Geodesy: Hydrology and Limnology: Geochemistry and Geomagnetism)	raphy;
COS-02540 — EXILE EXIST IRIS-Mineral Exploration Investment Optimization and Resource Estimation Computer Program	ı 51
GSC-11597 — Geomagnetic Field and Field Line Calculation Computer Program KSC-10425 — SSCO1-Statistical Summary of Climatological Data Computer Program	51 r 52
MFS-21114 — Handbock for Estimating Toxic Fuel Hazards MFS-22838 — Four Dimensional World Wide Atmospheric Models MSC-14093 — A Program for Computing the Brightness Temperature of a Clear	5; 5; r 5;
Atmosphere from Radiosconde Data NPO-11892 — AIRPOL-Wind Trajectory Tracing for Air Pollution Studies UGA-02330 — QUAL 1-Simulation of Water Quality in Streams and Canals UGA-02340 — DOSAG 1-Simulation of Water Quality in Streams and Canals	53 53 54
INSTRUMENTATION AND PHOTOGRAPHY	
Includes Design, Installation; and Testing of Instrumentation Systems; Sensors and ducers; Photography (Including Optical, Aerial, and Radar Photography); Infrared hology; Display Systems; Data Recording and Processing)	Trans. Tech
FRC-10017 — Optical Systems Ray Tracing GSC-11393 — OSTRI-Optical Systems Ray Tracing Computer Program GSC-12079 — SMIPS-Small Interactive Image Processing System LAR-11873 — CONVERT-Technique and Computer Program for Calculating Photo	55 55 56 - 56
graphic Film Density Variations MFS-18483 — Instrumentation Reliability Analysis Program MFS-23033 — Digital Image Registration Method Based Upon Binary Boundary	56 , 56
Maps MSC-14690 — ASTEP-Algorithm Simulation Test and Evaluation Program MSC-14823 — LARSYS III-Multispectral Data Analysis System, Release 3.1 NPO-10503 — FOLDP-FORTRAN Optical Lens Design Program NPO-13415 — VICAR: Vicar Image Communication and Retrieval System (IBM 360-55 Programming System (44 PS Monitor) GSC-12076 — VICAR: Vicar Image Communication and Retrieval System (IBM	57 57 57 1 57
360 370 OS Moniter)	. 3/

FLUID MECHANICS	
Includes Boundary Layer Flow; Compressible Flow; Gas Dynamics; Hydrodynamics furbulence)	ar
GSC-12009 — MULTIWICK: A Computer Program that Numerically Integrates the Differential Equations that Describe the Hydrodynamics of a Large Class of Heat Pipes	
LAK-10990 — Compressible Laminar or Turbulent Nonsimilar Boundary Layers	4
LAR-11048 — Program to Determine Radiating, Nonarijabatic, Inviscid Flow Over	4
LEW-11859 — CFNA-Compressible Flow Network Analysis Computer Program LEW-12286 — Computer Program for Outst-One Program	4
LEW-12326 — Calculation of Supersonic Stream Parameters of a Real Gas from	4
MFS-00443 — Solution of Compressible Flows in Piping Systems MFS-14683 — Compressible Flow Computer Breastantian	4
MFS-24172 — Computer Program for Pressure Drop and Dumains D	4
Flow through Round Tubes MSC-17566 — SMAC-Simplified Marker and Cell Method for Calculating Incompressible Fluid Flows	5
MSC-19178 — DUCT-Adjabatic Compressible Flow Duck As 1	5
Nozzle Solution of Transonic Flow in a Convergent-Divergent	54 54
NUC-10376 — Computer Program for Analyzing Piping Systems	50
GEOPHYSICS	
ncludes Aeronomy: Upper and Lower Atmosphere Studies: Oceanography: Cartograp	
decementary and Geomagnetism)	hy;
COS-02540 — EXILE EXIST IRIS Mineral Exploration Investment Optimization and Resource Estimation Computer Program	51
KSC-10425 — SSC01-Statistical Summary of Climatological Data Computer	51 52
MFS-21114 — Handbook for Estimating Toxic Fuel Hazards MFS-22838 — Four Dimensional World Wide Atmospheric Models MSC-14093 — A Program for Computing the Brightness Temperature of a Clear Atmosphere from Radiosconde Data	52 52 53
NPO-11892 — AIRPOL-Wind Trajectory Tracing for Air Pollution Studies UGA-02330 — QUAL 1-Simulation of Water Quality in Streams and Canals UGA-02340 — DOSAG 1-Simulation of Water Quality in Streams and Canals	53 53 54
INSTRUMENTATION AND PHOTOGRAPHY	
cludes Design, Installation; and Testing of Instrumentation Systems; Sensors and Trarecers; Photography (Including Optical, Aerial, and Radar Photography); Infrared Tecopy; Display Systems; Data Recording and Processing)	ıs. :h.
FRC-10017 - Ontical Systems Pay Tracing	55
GSC-12079 — SMIPS.Small Interactive Image Processing System LAR-11873 — CONVERT-Technique and Computer Program for Calculating Photo	55 56 56
MFS-18483 — Instrumentation Reliability Analysis Program MFS-23033 — Digital Image Registration Method Program	56 56
MSC-14690 — ASTEP-Algorithm Simulation Test and Evaluation Program MSC-14823 — LARSYS III-Multispectral Data Analysis System, Release 3.1 NPO-10503 — FOLDP-FORTRAN Optical Lang Postar Reviews 1.1	57 57 57
	57
GSC-12076 — VICAR: Vicar Image Communication and Retrieval System (IBM 360 370 OS Moniter)	57

MACHINE ELEMENTS AND PROCESSES

(Includes Bearings and Gears, Seals, Pumps, Vacuum Technology; Lubrication and Lubricants; Friction and Wear; Materials Fabrication; Numerically Controlled Machining; Manufacturing Processes and Quality Control; Structures and Component Reliability Analysis) LAR-11261 — Systems Identification Using a Modified Newton-Raphson Method LEW-11033 — Investigation of Isothermal Compressible Flow Across a Rotating Sealing Dam

LEW-11110 — Computer Program for Calculating the Temperature Field of Face Sealis 60 LEW-11511 - Evaluation of Rotating Incompressibly Lubricated Pressurized LEW-11311 — Evaluation of Rotating Incompressibly Lubricated Pressurized
Thrust Bearings
LEW-11679 — FORTRAN Programs for the Design of Liquid-to-Liquid Jet Pumps
LEW-11910 — Computer Program for Calculating Critical Speeds of Rotating
Shafts
LEW-12008 — Program for Calculating Critical Speeds of Rotating 60 60 60 Shafts

LEW-12008 — Program for Calculating Total Efficiency-Specific-Speed Characteristics of Centrifugal Compressors acteristics of Centrifugal Compressors

MFS-12641 — Bellows Calculation Program, IBM 360 Version

MFS-14513 — RAM-Reliability Analysis Model

MFS-16499 — Exact Minimal Path and Minimal Cut Techniques for Determining System Reliability

MFS-24034 — APRDCT-Apportionment Prediction

MFS-24121 — ERSION 3 Reliability Goal Status

MFS-24124 — SCOPE-System for Computing Operational Probability Equations

MFS-24384 — SCOPE-System for Computing Operational Probability Equations

MSC-17530 — Optimization of Fluid Line Sizes with Pumping Power Penalty

MSC-17930 — Optimization of Fluid Line Sizes with Pumping Power Penalty

MSC-19491 — Reinforced Carbon-Carbon Mass Loss

NUC-10402 — TRACE-Fault Tree Computer Code Agalyzes Large and Complex Systems to Identify and Eliminate Combinations of Malfunctions, Failures, and Hazards 61 62 62 62 62 62 63 63

MATHEMATICS

(Includes Numerical Analysis Techniques Such as Error Analysis, Function Evaluation, Numerical Integration and Differentiation, Differential and Integral Equation Solution; Combinatorial and Discrete Mathematics; Mathematical Programming; Mathematical Statistics and Probability)

istics and Probability)	65
ARC-10165 — Spearman Rho Multiple Rank Order Correlation Program ARC-10168 — AESOP-Automated Engineering and Scientific Optimization Program ARC-10577 — Finding An Extremum of a Bounded Multivariable Function Without ARC-10577 — Programman Rho Multiple Programman Archives Programman Research Programman Rho Multiple Rank Order Correlation Programman Rho Rho Rho Rho Rho Rho	65 66
	66
APC 10336 CONMIN A Fortran Program to	66
COS.02530 — TIDEDA TITLE DE PETAL SE Experimentar Jackage	66
GSC-11499 — Sturiet of Integration by Gaussian Quadrature	67 87
GSC-11950 — NUM Program Analysis Program	67
HON 10735 - Bellcomm's Approximation	67
HON 10729 RAHCOMM LINED OF STATE AND COMMUNICAL PROGRAM	67
KSC.10418 — LPII LaGrange Three Point Interpolation Computer 17 (KSC.10418) — FORTRAN IV Program for Symbolic Solution of Up to 20 Simul- LEW-10439 — FORTRAN IV Program for Symbolic Solution of Up to 20 Simul-	68
1 EW-10139 - FURTRAIN IN TIONISM	68
A PULL 10020 MATAR Conversational Approach to Manual	68
1 FW-10917 - Computer Florida No. Breatten for Multiple Linear Regression	68
LEW-11052 — RAPIER FOR The Internative Evaluated Remodeling	69
	69
1 FW 11651 FD1 US-1 UN10000 1 1680000	
by the Method of Least Squares Nutricle Linear Regression and Data	69
by the Method of Least Squares by the Method of Least Squares LEW-11842 — NEWRAP An Improved Multiple Linear Regression and Data Analysis Computer Program Analysis Computer Program	70
Analysis Company Moulton Integration Subroutine	70
sace of 129 Chillier rechinque inchimic Achie of Arbitrary Matrices	70
MFS-00128 — Outlier Technique Program MFS-02368 — Calculation of Eigenvalues and Eigenvectors of Arbitrary Matrices MFS-02368 — Calculation of Eigenvalues and Eigenvectors of Arbitrary Matrices	70
LICE 02386 - John Haustenmitten Chine	٦,
Solution of Large Sets of Simultaneous Linear Equations with	71
Banden Symmetric matter and Equations	71
MFS-12981 — RKADAM Subroutine to Solve Differential Equations MFS-13122 — DENORD Solution of Differential Equations Using the Nordsieck	71
MFS-13122 — DENORD Solution of Silver	٠,
Method	71 72
MFS-18565 — FORIER-Subroutines for Lens Lesign Transfer Analysis MFS-21955 — Method for Nonlinear Exponential Regression Analysis	. "
ML 2-71305	

MFS-22136 — Selection of Approximating Funnctions for Tabulated Numerical Data	72
MFS-22994 — A Computer Program for Standard Statistical Distributions (IBM Version)	. 72
MFS-21466 — A Computer Program for Standard Statistical Distributions (UNI- VAC Version)	72
MFS-24100 — TEMPO Technique for Evaluating Multiple Probability Occurrences MSC-14094 — Polynomial Matrix Equation Solver	72 73
MSC-14147 — UHELP-University of Houston Easy Linear Programming System MSC-17560 — Algorithm for Matrix Bandwidth Reducation	73
MSC-19078 — Addition Convolution Computer Program for Cost Risk Analysis MSC-19289 — Routines for 3-D Vector Computations	73 73
MSC-19475 — Statistical Table Value Estimation (t and Chi Square) NPO-10614 — VERGE-Computer Subroutine to Accelerate the Convergence of	74 74
Iterative Processes NPO-10786 — SPLINT Parabolic Spline Interpolation Subroutine	74
NPO-11528 — Random Number Generator NPO-11649 — RETI-One-Dimensional Real Fourier Transform	74 74
NPO-1161 — CFT-Multi-Dimensional Complex Fourier Transform NPO-11718 — ROMBS Modified Single Precision Romberg Quadrature Subroutine	75 75
NPO-11805 — STURM-Eigenvalue Routine by Sturm Sequence Method	75
NPO-13304 — Reliability Computation from Reliability Block Diagrams NPO-13344 — SPIN-Spining Structures Eigenproblem Solver	75 76

STRUCTURAL MECHANICS

(Includes Structural Element Design and Weight Analysis; Fatigue Studies for Structures and Components; Stress Including Thermal) Calculation and Analysis of Structures; Analysis of Vibration and Damping in Structures; Analysis of Shell Structures Including Stresses, Loads, Buckling and Vibration)

```
COS-02350 — MASFLAY-Finite Element Mesh Generation Program COS-02410 — Isometric Piping System Drawing and Material Takeoff Program DOD-00033 — BANDIT-Structural Matrix Bandwith Reduction Computer Program
                                                                                                                                                                                                                             78
 (CDC)
DOD-00034 — BANDIT-Structural Matrix Bandwith Reduction Computer Program
                                                                                                                                                                                                                             78
                                   (IRM)
 DOD-00035 - BANDIT-Structural Matrix Bandwith Reduction Computer Program
                                                                                                                                                                                                                             78
                                    (UNIVAC)
 DOD-00054 -
                                   BANDIT-Structural Matrix Bandwith Reduction Computer Program
                                                                                                                                                                                                                             78
DOD-00054 — BANDIT-Structural Matrix Bandwith Reduction Computer Program
(Honeywell)

DOD-00024 — MEC21-Pipe Flexibility Analysis Program (IBM Version)
DOD-00025 — MEC21-Pipe Flexibility Analysis Program (UNIVAC Version)
DOD-00026 — MEC21-Pipe Flexibility Analysis Program (CDC Version)
DOD-00027 — MEL40-Piping Flexibility Analysis Program
DOD-00030 — SHCP-Ship Hull Characteristics Program
DOD-00030 — TOWER12-Guyed Tower Analysis Computer Program
DOD-00041 — Midship Section Design for Naval Snips
DOD-00050 — GRID2D-IGFES: Two Dimensional Grid Generator and Terminal Control System
GSC-11039 — Automated Input Data Preparation for NASTRAN
                                                                                                                                                                                                                             78
                                                                                                                                                                                                                            78
78
78
79
                                                                                                                                                                                                                             79
 GSC-11039 — Automated Input Data Preparation for NASTRAN
 HQN-10677 — Advanced Structure Geometry Studies
LAR-10473 — Structural Synthesis of a Stiffened Cylinder
LAR-10736 — Geometrically Nonlinear Analysis of Arbitrarily Loaded Shells of
                                                                                                                                                                                                                             80
                                                                                                                                                                                                                             80
                                    Revolution
LAR-11109 — Geometrically Nonlinear Static and Dynamic Analysis of Arbitrarily Loaded Shells of Revolution

LAR-11369 — Computer Program for Stress, Vibration, and Buckling Characteristics of General Shells of Revolution
                                                                                                                                                                                                                             81
                                                                                                                                                                                                                             81
 LAR-11529 — SNAP Dynamic Structural Network Analysis Program, CDC 6000 Series Version

LAR-11530 — SNAP-Static Structural Network Analysis Program, CDC 600 Series
                                                                                                                                                                                                                             82
                                                                                                                                                                                                                             83
Version

LAR-11569 — SALORS-Structural Analysis of Layered Orthotropic Ring Stiffened Shells of Revolution, Linear Stress Analysis Option

LAR-11696 — BUCLAP2-A Computer Program for Instability Analysis of Laminated Long Plates Subjected to Combined Inplane Loads

MFS-01488 — Torsional Vibration Natural Frequencies Program

MFS-02227 — Column Analysis Complex

MFS-12622 — Kellogg Piping Analysis Program, IBM-360 Version

MFS-13217 — Stress Analysis of Belleville Springs Program

MFS-15302 — SAMECS-Structural Analysis Method for Evaluating Complex Structures
                                                                                                                                                                                                                             83
                                                                                                                                                                                                                             83
                                                                                                                                                                                                                             84
                                                                                                                                                                                                                             84
                                   Structures
 MFS-20648 — Forsion Analysis of Open Sections
MFS-21432 — Vibrational Transfer Functions for Base Excited Systems
```

	MFS-21490 — FORMA-Synthesis of Dynamic Systems Using FORTRAIN Matrix	65
	MFS-21531 — SNAP Dynamic Structural Network Analysis Program, UNIVAC 1103	85
	MFS-21970 — ASTROX. Automated Shell Theory for Rotating Structures MFS-23027 — STARS2S-Shell Theory Automated for Rotational Structures	86 86
	(Statics) MFS-23172 — PANES Program for Analysis of Honlinear Equilibrium and Stability	86
	MFS.24042 — Remote Access Terminal Circular Frame Computer Program MFS.24043 — FRAP Pressurized Structure Optimization	86 85
	MSC.12706 — CAPR Compression Allowable Plotting Routine	87 87
	MSC-13995 - Fracture Mechanics of Apollo Spacecraft Pressure Vessels MSC-14746 - SOR Shells of Revolution (CDC 6000 Version)	87
	MSC-14749 — SOR-Shells of Revolution (IBM 360 Version)	87 87
	MSC-17031 — Geometry Processor, Mesh Topology and Nodal Point Generator MSC-17562 — FMA-Frame Modal Analysis	88
	MSC.17619 — Program to Reduce the Size of Structural Matrices	88 88
	MSC-17931 — STRESS-Structural Thermal Rapid Evaluation-Stresses and Strains LAR-10050 — SAMIS-Structural Analysis and Matrix Interpretive System (CDC Version)	83
	NPO.11319 — SAMIS Structural Analysis and Matrix Interpretive System (UNIVAC Version)	88
	NPO-11555 — ELASS-A General Purpose Digital Computer Program for the Equilibrium Problems of Linear Structures	89
	NPO-11943 — COMTANK-Structural Design and Stress Analysis Program for Advanced Composite Filament-Wound Axisymmetric Pressure Vessels	89
	NPO-13322 — WAVEFRONT-Structural Stiffness Matrix WaveFront Resequencing Program	89
	NUC-10342 — Finite Element Analysis of Compressible Solids with Nonlinear Material Properties	90
	THERMODYNAMICS AND COMBUSTION	
Inc The	cludes Thermodynamic and Transport Properties; Combustion Processes and Analy rmal Protection Systems; Heat Transfer; and Heat Exchangers)	ysis;
	DOD-00007 — Subroutine for the Thermodynamic Properties of Steam and Water GSC-11158 — Nodal Network Thermal Balance Program	91 91
	LAR-10794 — General Transient Heat Transfer Computer Program for Thermally Thick Walls	91
	LAR-11049 — Program for the Transient Response of Ablating Axisymmetric Bodies Including the Effect of Shape Change	92
	LEW-10254 — FORTRAN IV Program for Calculation of Thermodynamic Data LEW-11629 — Computer Program for Calculating the Thermodynamic and Trans-	92 92
	port Properties for Eight Fluids-Helium, Methane, Neon, Nitrogen,	
	Carbon Monoxide, Oxygen, Argon, Carbon Dioxide LEW.11854 — AChtA Aerotherm Charring Materials Ablation Computer Program	92
	LEW-12110 — Regenerative Cooling Design and Analysis Computer Program	92 93 93 93 93 93 94 94
	LEW-12206 — Computer Program for Calculating Water and Steam Properties MFS-15055 — BETA II-Boeing Engineering Thermal Analyzer	93
	MFS-15148 — Thermal Analysis of Fluid Flow in a Pipe	93
	MFS-21075 — RAV. AC-Radiation View Factor Program MFS-21082 — FNG-Fluid Network Generator	93
	MSC-13805 — SINDA-Systems Improved Numerical Differencing Analyzer	94
	MSC-17026 — General Heat Transfer Program	94
	MSC-19184 — Phase Change Subroutine for Use with Finite Differencing Programs MSC-19500 — Determination of View Factors to Finite Surfaces Using the H-P	94 94
	Desk Computer	
	NUC-10049 — Computer Program for the Steady-State Temperature Analysis of Plane or Axisymmetric Bodies	95
	NUC-10189 — TRACK-Compliter Program for Transient and Steady State Coupled Fluid Flow and Heat Conduction Analysis	95
	NUC.10241 — AUTOTEM-A Computer Program for Automated Geometry Meshing	95
	and Heat Conduction Calculation	

AERODYNAMICS

Includes aerodynamics of bodies, wings, rotors, and control surfaces; internal flow in ducts and turbo-machinery.

Vortex-Lattice FORTRAN Program for Estimating Subsonic Acrodyanmic Characteristics of Complex Planforms

In recent years, some wings have become very complex because of the varied speed regimes in which they are required to operate. In order to solve the problems of preliminary designs or parametric evaluations, a computer program has been developed for estimating the subsonic aerodynamic characteristics of complex planforms. The program represents the lifting planforms with a vortexlattice. These complex planforms include wings with variable-sweep outer panels, wings with several changes in dihedral angle across the span, wings with twist and/or camber, and a wing in conjunction with either tail or a canard. The aerodynamic characteristics of interest are lift and pitching moment for both the flat and/or twisted wing, drag due to lift parameter, leading edge thrust, leading edge suction, distributions of leading-edge thrust and suction coefficients, distributions of several span loading coefficients, distribution of lifting pressure coefficient, damping-in-pitch parameter, damping-in-roll parameter, and lift coefficient due to pitch rate. The program uses a minimum of input data to describe relatively complex planforms. These planforms may be described by up to 24 fine segments cin a semispan. They may have an outboard variable-sweep panel or they may have several dihedral angles across the span. In addition, two planforms may be used together to represent a combination of wings and tails or wings, bodies, and tails. The analysis has been extended to handle planforms in a sidewash field. The documentation provides examples and typical running times of various types of configurations which can be used. In addition, the results of parametric applications of the program are presented to provide guidance in specifying vortex lattice airangements which can be expected to give acceptable results

LANGUACE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,572 source statements
PRICE: Program \$680,00 Documentation \$15 50
PROGRAM NUMBER: LAR-11047

Computer Program to Determine Pressure Distribution and Forces on Blunt Bodies of Revolution

The process described in the NASA Technical Note, NASA TN D-4865, for obtaining the surface pressures along meridian lines of blunt bodies of revolution has been

programmed for high-speed digital computation. The computer program has been written to include the integration of the surface pressures in order to obtain the axial force, normal-force, and pitching-moment coefficients. The program reads in the body geometry in terms of a spherical nosecap radius and x, y coordinates starting at the point of tangency to the nose cap. The program then generates for the desired radial angles 0 the equivalent bodies which represent the chape of the meridian lines of the body at the input angle of attack. The program represents the longitudinal shape of these bodies by straight line elements between the transformed input coordinates. The spherical cap from the stagnation point to the tangency point is represented by 20 straight-line segments. After the equivalent bodies are obtained, the pressure distributions are computed and integrated along the respective meridian lines of the input body to obtain the forces and moments. By selecting output options, the pressure and Mach number variations for each meridian line can be obtained with the forces and moments or just the forces and moments can be output.

LANGUAGE: CDC FORTRAN Extended
MACHINE REQUIREMENTS: CDC JO00 Series
PROGRAM SIZE: Approximately 879 source statements
PRICE: Program \$330.00 Documentation \$13.00
PROGRAM NUMBER: LAR-11197

An Improved Method for the Aerodynamic Analysis of Wing-Body-Tail Configurations in Subsonic and Supersonic Flow

A new method has been developed for calculating the pressure distribution and aerodynamic characteristics of wing-body tail combinations in subsonic and supersonic potential flow. A computer program has been developed to perform the numerical calculations. The configuration surface is subdivided into a large number of panels, each of which contains an aerodynamic singularity distribution. A constant source distribution is used on the body panels, and a vortex distribution having a linear variation in the streamwise direction is used on the wing and tail panels. The normal components of velocity induced at specified control points by each singularity distribution are calculated and make up the coefficients of a system or linear equations relating the strengths of the singularities to the magnitude of the normal velocities. The singularity strengths which satisfy the boundary condition of tangential flow at the control points for a given Mach number and

angle of attack are determined by solving this system of equations using an iterative procedure. Once the singularity strengths are known, the pressure coefficients are calculated, and the forces and morrents acting on the configuration determined by numerical integration. The new method contains a number of unique features which are considered improvements over the former methods available for solving this problem. The u, v, and w components of velocity induced by surface distributions of sources and vortices at arbitrary points in the flow field are derived by an extended version of a current theory. The new method includes panels inclined to the free stream direction in both subsonic and supersonic flow, which allows a complete surface panel representation of the configuration and a corresponding improvement in the aerodynamic solution. In particular, it permits the analysis of non-circular bodies and the calculation of wing body interference effects in the presence of body closure, two feat ires not available in the original method. In addition, the use of a vortex distribution having a linear variation in the streamwise direction results in improved chordwise pressure distributions on wing and tail surfaces. The computer program is written in FORTRAN IV for the CDC-6600 computer, occupies 70,000 (octal) words and operates in overlay mode. The program requires five peripheral storage disc-files in addition to the input and output files.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 6,594 source statements
PRICE: Program \$960.00 Documentation \$27.50
PROGRAM NUMBER: LAR-11305

Modified Multhopp Lifting Surface Method of Aero Characteristics

This program determines the longitudinal subsonic aerodyanmic characteristics of wings, which may be composite, by an extension of the approach used by Multhopp. The solution is based on linearized potential flow with compressibility being accounted for by use of the Prandtl-Glauret factor. The characteristics determined include the overall lift-curve slope, the overall pitchingmoment-curve slope, the aerodynamic center, the ratio of the induced drag based on the spanwise distribution of circulation to the lift coefficient, and many of the section features. The loadings for wings with twist and camber can also be computed. Since a large portion of this program is concerned with computation of required geometric representation, two additional routines are included to aid in obtaining this geometric input data for the program. One routine determines the aspect ratio of a wing which can have a broken leading and trailing edge and skewed tip. In addition, the program can iterate on the trailing edge sweep to determine the required angle to give a particular aspect ratio. The other routine determines the X and Y location of the pivot that an arrow wing with a skewed tip in its high sweep position must have in order for: (1) the pivot to occur at a certain fraction of the high sweep normal chord, and (2) the outer panel in the low sweep position to have a certain specified span increase over that of the high sweep wing.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2.023 source statements
PRICE Program \$440 00 Documentation \$12.50
PROGRAM NUMBER: LAR-11573

A Computer Program for Calculating Imriacid, Adiabatic Flow About Blunt Bodies Traveling at Superconic and Hyperconic Speeds at Angle of Attack

This is a computer program which calculates inviscid plane, axisymmetric, and three ulmensional flow about blunt bodies traveling at supersonic and hypersonic speeds in a uniform free stream. An exact time-dependent finite-difference method of second order accuracy is used. The bodies which can be treated include plane and axisymmetric bodies. Equilibrium air and perfect gas thermodynamic models can be used and a procedure for approximating equilibrium gases with the perfect gas model is also described. The results of the program include the shock-wave location and the flow properties at a number of grid points on the body surface, on the shock-wave, and in the region between the body and shock.

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 1,709 source statements
PRICE Program \$340 00 Documentation \$9.00
PROGRAM NUMBER: LAR-11663

Subsonic Annular Wing Theory With Application to Flow About Nacelles

This program was written to assist in the design of high-bypass-ratio fan engine nacelles. These nacelles can be treated as annular wings on which the circulation developed determines both the external and internal flow. The program was developed for calculating the flow over a nacelle at zero angle of attack and at subsonic Mach numbers. The method uses the annular wing theory and boundary-layer theory and has shown good correlation to experimental data. The method permits variation of the mass flow by changing the size of a center body.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 1,442 source statements
PRICE Program \$510.00 Documentation \$10.50
PROGRAM NUMBER: LAR-11727

Computer Program for Calculating Flow Distribution in a Radial Inflow Turbine

This computer program provides a flow analysis of a radial inflow gas turbine. The program obtains a meridional solution on the mean surface between the blades. followed by solutions on hub, mean, and shroud blade-toblade surfaces, in a single computer run. Suggestions for modifying the program for use with other types of turbomachines are given. Techniques for overcoming convergence problems are discussed. The method used is based on an equation for the velocity gradient along an arbitrary quasi-orthogonal between blades and is similar to a method using quasi-orthogonals in a meridional plane. With this method, a streamline analysis can be made for any blade to blade stream surface. This surface, if desired, may be assumed to be a surface of revolution generated by a meridional streamline obtained from a meridional streamline analysis. On this stream surface a twodimensional solution for the velocity and pressure distributions is obtained. With several such blade-to-blade solutions, the velocity distribution throughout the rotor passage can be calculated. Simplifying assumptions for upstream and downstream conditions are made for the purpose of readily obtaining a reasonable approximation near the inlet and outlet.

angle of attack are determined by solving this system of equations using an iterative procedure. Once the singularity strengths are known, the pressure coefficients are calculated, and the forces and moments acting on the configuration determined by numerical integration. The new method contains a number of unique features which are considered improvements over the former methods available for solving this problem. The u, v, and w components of velocity induced by surface distributions of sources and vortices at arbitrary points in the flow field are derived by an extended version of a current theory. The new method includes panels inclined to the free stream direction in both subsonic and supersonic flow, which allows a complete surface panel representation of the configuration and a corresponding improvement in the aerodynamic solution. In particular, it permits the analysis of non-circular bodies and the calculation of wing-body interlerence effects in the presence of body closure, two feat ires not available in the original method. In addition, the use of a vortex distribution having a linear variation in the streamwise direction results in improved chordwise pressure distributions on wing and tail surfaces. The computer program is written in FORTRAN IV for the CDC-6600 computer, occupies 70,000 (octal) words and operates in overlay mode. The program requires five peripheral storage disc-files in addition to the input and output files.

LANGUAGE: FORTRAN IV
MACHINE RECUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approxmately 6,594 source statements
PRICE: Program \$960 00 Documentation \$27 50
PROGRAM NUMBER: LAR-11305

Modified Multhopp Lifting Surface Method of Aero Characteristics

This program determines the longitudinal subsonic aerodyanmic characteristics of wings, which may be composite, by an extension of the approach used by Multhopp. The solution is based on linearized potential flow with compressibility being accounted for by use of the Prandtl-Glauret factor. The characteristics determined include the overall lift-curve slope, the overall pitchingmoment-curve slope, the aerodynamic center, the ratio of the induced drag based on the spanwise distribution of circulation to the lift coefficient, and many of the section features. The loadings for wings with twist and camber can also be computed. Since a large portion of this program is concerned with computation of required geometric representation, two additional routines are included to aid in obtaining this geometric input data for the program. One routine determines the aspect ratio of a wing which can have a broken leading and trailing edge and skewed tip. In addition, the program can iterate on the trailing edge sweep to determine the required angle to give a particular aspect ratio. The other routine determines the X and Y location of the pivot that an arrow wing with a skewed tip in its high sweep position must have in order for: (1) the pivot to occur at a certain fraction of the high sweep normal chord, and (2) the outer panel in the low sweep position to have a certain specified span increase over that of the high sweep wing.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,023 source statements
PRICE Program \$440.00 Documentation \$12.50
PROGRAM NUMBER: LAR-11573

A Computer Program for Calculating Inviscid, Adiabatic Flow About Blunt Bodies Traveling at Superronic and Hypersonic Speeds at Angle of Attack

This is a computer program which calculates inviscid plane, axisymmetric, and three ulmensional flow about blunt bodies traveling at supersonic and hypersonic speeds in a uniform free stream. An exact time-dependent finite-difference method of second order accuracy is used. The bodies which can be treated include plane and axisymmetric bodies with sharp shoulders and smooth nonaxisymmetric bodies. Equilibrium air and perfect gas thermodynamic models can be used and a procedure for approximating equilibrium gases with the perfect gas model is also described. The results of the program include the shock-wave location and the flow properties at a number of grid points on the body surface, on the shock-wave, and in the region between the body and shock.

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS CDC 6000 Series
PROGRAM SIZE: Approximately 1,709 source statements
PRICE Program \$340 00 Documentation \$9.00
PROGRAM NUMBER: LAR-11663

Subsonic Annular Wing Theory With Application to Flow About Nacelles

This program was written to assist in the design of high-bypass-ratio fan engine nacelles. These nacelles can be treated as annular wings on which the circulation developed determines both the external and internal flow. The program was developed for calculating the flow over a nacelle at zero angle of attack and at subsonic Mach numbers. The method uses the annular wing theory and boundary-layer theory and has shown good correlation to experimental data. The method permits variation of the mass flow by changing the size of a center body.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Scries
PROGRAM SIZE: Approximately 1.442 source statements
PRICE Program \$310.00 Documentation \$10.50
PROGRAM NUMBER: LAR-11727

Computer Program for Calculating Flow Distribution in a Radial Inflow Turbina

This computer program provides a flow analysis of a radial inflow gas turbine. The program obtains a meridional solution on the mean surface between the blades. followed by solutions on hub, mean, and shroud blade-toblade surfaces, in a single computer run. Suggestions for modifying the program for use with other types of turbomachines are given. Techniques for overcoming convergence problems are discussed. The method used is based on an equation for the velocity gradient along an arbitrary quasi-orthogonal between blades and is similar to a method using quasi-orthogonals in a meridional plane. With this method, a streamline analysis can be made for any blade to blade stream surface. This surface, if desired, may be assumed to be a surface of revolution generated by a meridional streamline obtained from a meridional streamline analysis. On this stream surface a twodimensional solution for the velocity and pressure distributions is obtained. With several such blade-to-blade solutions, the velocity distribution throughout the rotor passage can be calculated. Simplifying assumptions for upstream and downstream conditions are made for the purpose of readily obtaining a reasonable approximation near the inlet and outlet.

angle of attack are determined by solving this system of equations using an iterative procedure. Once the singularity strengths are known, the pressure coefficients are calculated, and the forces and moments acting on the configuration determined by numerical integration. The new method contains a number of uniq le features which are considered improvements over the former methods available for solving this problem. The u, v, and w components of velocity induced by surface distributions of sources and vortices at arbitrary points in the flow field are derived by an extended version of a current theory. The new method includes panels inclined to the free stream direction in both subsonic and supersonic flow, which allows a complete surface panel representation of the configuration and a corresponding improvement in the aerodynamic solution. In particular, it permits the analysis of non-circular bodies and the calculation of wing-body interference effects in the presence of body closure, two feat ires not available in the original method. In addition, the use of a vortex distribution having a linear variation in the streamwise direction results in improved chordwise pressure distributions on wing and tail surfaces. The computer program is written in FORTRAN IV for the CDC-6600 computer, occupies 70,000 (octal) words and operates in overlay mode. The program requires five peripheral storage disc files in addition to the input and output files.

LANGUAGE: FORTRAN IV
MACHINE RECUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approxmately 6.594 source statements
PRICE: Program \$960.00 Documentation \$27.50
PROGRAM NUMBER: LAR-11305

Modified Multhopp Lifting Surface Method of Aero Characteristics

This program determines the longitudinal subsonic aerodyanmic characteristics of wings, which may be composite, by an extension of the approach used by Multhopp. The solution is based on linearized potential flow with compressibility being accounted for by use of the Prandtl-Glauret factor. The characteristics determined include the overall lift-curve slope, the overall pitchingmoment-curve slope, the aerodynamic center, the ratio of the induced drag based on the spanwise distribution of circulation to the lift coefficient, and many of the section features. The loadings for wings with twist and camber can also be computed. Since a large portion of this program is concerned with computation of required geometric representation, two additional routines are included to aid in obtaining this geometric input data for the program. One routine determines the aspect ratio of a wing which can have a broken leading and trailing edge and skewed tip. In addition, the program can iterate on the trailing edge sweep to determine the required angle to give a particular aspect ratio. The other routine determines the X and Y location of the pivot that an arrow wing with a skewed tip in its high sweep position must have in order for. (1) the pivot to occur at a certain fraction of the high sweep normal chord, and (2) the outer panel in the low sweep position to have a certain specified span increase over that of the high sweep wing

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,023 source statements
PRICE Program \$440.00
PROGRAM NUMBER: LAR-11573

A Computer Program for Calculating Invited, Adiabatic Flow About Blunt Bodies Traveling at Superronic and Hypersonic Speeds at Angle of Attack

This is a computer program which calculates inviscid plane, axisymmetric, and three ulmensional flow about blunt bodies traveling at supersonic and hypersonic speeds in a uniform free stream. An exact time-dependent finite difference method of second order accuracy is used. The bodies which can be treated include plane and axisymmetric bodies with sharp shoulders and smooth nonaxisymmetric bodies. Equilibrium-air and perfect gas thermodynamic models can be used and a procedure for approximating equilibrium gases with the perfect gas model is also described. The results of the program include the shock wave location and the flow properties at a number of grid points on the body surface, on the shock wave, and in the rigion between the body and shock.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 1,709 source statements
PRICE Program \$340.00
PROGRAM NUMBER: LAR-11663

Subsonic Annular Wing Theory With Application to Flow About Nacelles

This program was written to assist in the design of high-bypass-ratio fan engine nacelles. These nacelles can be treated as annular wings on which the circulation developed determines both the external and internal flow. The program was developed for calculating the flow over a nacelle at zero angle of attack and at subsonic Mach numbers. The method uses the annular wing theory and boundary layer-theory and has shown good correlation to experimental data. The method permits variation of the mass flow by changing the size of a center body.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Scries
PROGRAM SIZE: Approximately 1.442 source statements
PRICE: Program \$510.00
PROGRAM NUMBER: LAR-11727

Computer Program for Calculating Flow Distribution in a Radial Inflow Turbine

This computer program provides a flow analysis of a radial inflow gas turbine. The program obtains a meridional solution on the mean surface between the blades, followed by solutions on hub, mean, and shroud blade-toblade surfaces, in a single computer run. Suggestions for modifying the program for use with other types of turbomachines are given. Techniques for overcoming convergence problems are discussed. The method used is based on an equation for the velocity gradient along an arbitrary quasi-orthogonal between blades and is similar to a method using quasi orthogonals in a meridional plane. With this method, a streamline analysis can be made for any blade to blade stream surface. This surface, if desired, may be assumed to be a surface of revolution generated by a meridional streamline obtained from a meridional streamline analysis. On this stream surface a twodimensional solution for the velocity and pressure distributions is obtained. With several such blade to blade solutions, the velocity distribution throughout the rotor passage can be calculate. Simplifying assumptions for upstream and downstream conditions are made for the purpose of readily obtaining a reasonable approximation near the inlet and outlet.

LANGUAGE: FORTRAN IV (89%), MAP (11%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 1,415 source statements
PRICE:Program \$460.00 Documentation \$14.00
PROGRAM RUMBER: LEW-00236

Computer Program for Analysis of Geometry and Design Point Performance of Axial Flow Turbines

This program was developed to solve the basic equations which govern the design-point performance of an axial flow turbine, avoiding lengthy and time-consuming numerical methods. The program is capable of analyzing both single and multispool units (a maximum of three spools is allowed). The program will determine the standard turbine design parameters at a pre-selected number of streamlines. These parameters will be consistent with the requirement of radial equilibrium, the definition of blade element performance being used for the analysis, and the input specifications of design requirements and analysis variables when a valid solution of the design problem exists. When used for the analysis of a single spool, designs for any number of sets of analysis variables may be computed consecutively.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,214 source statements
PRICE: Program \$460.00 Documentation \$28.00
PROGRAM NUMBER: LEW-10471

FORTRAN Program For Calculating Velocities and Streamlines on a Blade to Blade Stream Surface of a Tandem Blade Turbomachine

This computer program gives the blade-to-blade solution of the two-dimensional, subsonic, compressible (or incompressible), nonviscous flow problem for a circular or straight infinite cascade of tandem or slotted turbomachine blades. The blades may be fixed or rotating. The flow may be axial, radial, or mixed. The method of solution is based on the stream function using an itertize solution of nonlinear finite-difference equations. These equations are solved using two major levels of iteration. The inner iteration consists of the solution of simultaneous linear equations by successive overrelaxation, using an estimated optimum overrelaxation factor. The outer steration then changes the coefficients of the simultaneous equations to correct for compressibility. The program input consists of the basic blade geometry, the meridional stream channel coordinates, fluid stagnation conditions, weight flow and flow split through the slot, and inlet and outlet flow angles. The output includes blade surface velocities, velocity magnitude and direction throughout the passage, and the streamline coordinates.

LANGUAGE: FORTRAN IV (99%), MAP (1%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,583 source statements
PRICE: Program \$460.00 Documentation \$14.50
PROGRAM NUMBER: LEW-10743

Fortran IV Program to Estimate the Off Design Performance of Radial Inflow Turbines

This program is designed to calculate the off-design performance of radial inflow turbines. The analysis consists of a one-dimensional solution of flow conditions along the mean streamline, using perfect gas relations and is written for subsonic flow only, since stater choking is not

expected. The program uses the thermodynamic equations of rotor incidence loss and the calculation of additional performance parameters. Use of the program requires as input information the turbine flow areas, diameters, and blade angles. An estimate of design point performance is also necessary. The output consists of conventional performance parameters at specified flow conditions and speeds.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/7044 DCS
PROGRAM SIZE: Approximately 407 source statements
PRICE: Program \$280.00 Documentation \$8.50
PROGRAM NUMBER: LEW-10764

Computer Programs for Axial Flow Compressor Dezign

Four FORTRAN IV computer programs for the design of axial flow compressors have been developed. (1) The first of these programs was based on the assumption of simple radial equilibrium of static pressure and constant efficiency radially. In this program, limits on hub and tip ramp angles, axial velocity ratio across blade rows, rotor hub and stator tip loadings, rotor exit relative flow angle, and stator hub Mach number are specified; the velocity diagram and stage-by-stage performance are calculated. (2) The second program accounts for complete radial equilibrium of flow. Losses are evaluated on the basis of blade element loss prediction methods. Radial distribution of energy is specified as a polynomial variation of whirl velocities at the exit of each blade row; rotor tip leadings, limiting values of rotor hub relative exit angles, stator hup Mach numbers. stator hub loadings, and the compressor flow path are also specified. (3) Program 3 differs from Program 2 in that the radial distribution of total pressure is specified for each rotor blade row rather than the whirl velocity distribution, and there is the option of specifying the flow path or specifying the axial velocity ratios and calculating the resulting flow path. (4) The fourth program developed is an off-design perforr ance calculation. The calculation accounts for variable specific heat and full radial equilibrium and determines energy addition and adiabatic efficiencies on the basis of data for blade element turning and loss. The program user has available as options either double-circular-arc or NACA 65-series blade performance data, plus the capability of specifying reference incidence angle through tabular input for any individual blade row or through the criterion of suction surface tangency for any double-circular-arc blade row. The off-reference increment in deviation angle is furnished in the form of a correlation of selected NASA data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approxmately 14,251 source statements
PRICE: Program \$1,070.00 Documentation \$50.50
PROGRAM NUMBER: LEW-10765

Turble-Fortran Program for Calculating Velocities and Streamlines on a Blade-to-Blade Stream Surface of a Turbomachine

This program is a revision of an existing program for blade-to-blade aerodynamic analysis of turbornachine blades and it is a simpler program while consistent with related programs. The analysis is for two-dimensional, subsonic, compressible (or incompressible), nonviscous ficw in a circular or straight infinite cascade of blades, which may be fixed or rotating. The flow may be axial, radial, or mired, and the stream channel thickness may

change in the through-flow direction. The program input consists of blade and stream channel geometry, total flow conditions, inlet and outlet flow angles, and blade-to-blade stream channel weight flow. The output includes blade surface velocities, velocity magnitude and direction at all interior mesh points in the blade-to-blade passage, and streamline coordinates throughout the passage.

LANGUAGE: FORTRAN IV (98%), MAP (2%)
MACHINE PLOUIREMENTS: IBM-7094
PROGRAM *LE: Approximately 2,171 source statements
PRICE: Program \$480.00 Documentation \$5.50
PROGRAM HUMBER: LEW-10783

Magnify— Fortran Program for Calculating Vulcelties in a flagnified Region on a Blade to Glade Surface of a Turbomaci, no

This program obtains a total detailed solution around a leading or trailing edge or in a slot region for compressible, subsonic, nonviscous flow on a blade-to-blade surface between turbomachine blades. Using this program, a coarse mesh solution for an entire blade-to-blade region can be magnified by a chosen magnification factor in a small rectangular region. The program input requires information obtained from a less detailed solution from one of three programs: TURBLE, TANDEM, and 2DCP These programs are available from COSMIC. The output includes detailed surface velocities, velocity magnitude and direction, and stream function values throughout the magnified region. The method is based on the stream function with the solution of the simultaneous, nonlinear finite-difference equations being obtained by two major levels of iteration. The inner iteration consists of the solution of simultaneous linear equations by successive overrelaxation, using an estimated optimum overrelaxation factor. The outer iteration then changes the coefficient of the simultaneous equations to compensate for com-

LANGUAGE: FORTRAN IV (98%), MAP (2%)
MACHINE REQUIREMENTS: IBM-7094
aprogram size; approximately 2,516 source statements
PRICE: Program \$480.00
PROGRAM NUMBER: LEW-10769

Tsonic—Fortran Program For Calculating Transonic Vetocities on a Blade Stream Surface of a Turbomachine

This program obtains a transonic flow solution on a blade-to-blade surface between blades of a turbomachine. The flow must be essentially subsonic, but there may be locally supersonic flow. The solution is two-dimensional, isentropic, and shock-free. The baldes may be fixed or rotating. The flow may be axial, radial, or mixed, and there may be a change in stream channel thickness in the through-flow direction. A loss in relative stagnation pressure may be accounted for. The program input consists of blade and stream-channel geometry, stagnation flow conditions, irrier and outlet flow angles, and blade-to-blade stream-channel weight flow. The output includes blade surface velocities, velocity magnitude and direction at all interior mesh points in the blade-to-blade passage, and streamline coordinates throughout the passage. The transonic solution is obtained by a combination of a finite-difference, stream function solution and a velocity-gradient solution. The finite-difference solution at a reduced weight flow provides information needed to obtain a velocity gradient solution.

LANGUAGE: FORTRAN IV (98%), MAP (2%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,602 source statements
PRICE: Program \$480.00 Documentation \$10.50
PROGRAM NUMBER: LEV-10977

Analysis of Geometry and Deelgn Point Performance of Axial Flow Turbines Using Specified Meridional Velocity Gradients

This computer program uses a non-restrictive method for determining the alternative geometries and associated design point performance of axial-flow turbines capable of satisfying specified design requirements; it solves the flow field within the turbine without making the simplifying assumptions that result in restrictive designs. The program is capable of analyizing both single and multispool units (a maximum of three spools is allowed), and each spool, may have up to eight stages. The absolute and relative flow fields are computed at the first stator inlet, at each interblade row plane, and at the final rotor exit. The effects of the radial variation of the following quantities are taken into account: inlet conditions, streamline angle of inclination and curvature, loss coefficient or efficiency, meridional velocity, or angle. Further, the effects of coolant flows, interfilament mixing, and a station-to-station variation of specific heat can be included. As additional features, the program allows for: (1) the internal calculation of losses based on a correlation which has been developed for pressure-loss coefficient, and (2) either subsonic or supersonic solutions for the absolute velocity. The program will determine the standard turbine design parameters at a preselected number of streamlines. These parameters will be consistent with the requirement of radical equilibrium, the specified or calculated blade element performance, and the input specifications of design requirements. When used for the analysis of a single spool, designs for any number of sets of analysis variables may be computed consecutively. This program is a modification of LEW-10471 (M69-10338). It complements the original rather than replaces it in that not all of the originally selected optimal specifications of a design are made available in this new version. However, the new version can be used independently of the original for designs in which blade-element performance is directly specified by total pressure loss coefficients or indirectly by the coefficients of a correlation of the total pressureloss coefficient chosen for fully consistent analysis

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2.038 source statements
PRICE: Program \$490.00 Documentation \$21.00
PROGRAM NUMBER: LEW-11029

Fortran Program for Quasi-Three Dimensional Calculation of Surface Velocities and Choking Flow for Turbomachine Blade Rows

A computer program, CHANEL, has been developed to obtain a quasi-three dimensional solutions of surface velocities and choking flow for turbomachinery blade rows. The aerodynamic design of turbomachinery blades requires the determination of blade surface velocity distribution. Also, it is necessary to know the choking flow in many designs, there are significant velocity gradients both from blade-to-blade and from hub-to-tip. This condition necessitates consideration of the three-dimensional effects. One of the useful techniques for calculating surface velocities where three-dimensional

effects are of importance is the velocity gradient (stream filament) method. The general velocity gradient equation determines the velocity variation in any direction. In particular, the velocity gradient equation can be reduced to special cases to determine both the blade-to-blade and hub to tip variation in velocity. A combination of the velocity variation in two directions with a specified mass flow will determine the velocities at a passage cross section. This method works well in a well-guided passage. Some of the coinditions that can be handled by the CHANEL program could not be handled previously are: (1) Nonuniform inlet temperature, pressure, and prewhirl; (2) Nonaxial flow where meridional flow angle; (3) Meridional streamline curvature; (4) Radius can vary as desired from the hub to the tip.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 433 source statements
PRICE: Program \$370.00 Documentation \$6.50
PROGRAM NUMBER: LEW-11635

FORTRAN Program for Calculating Velocities in the Meridianal Plans of a Turbomachine

A computer program has been developed which calculates the velocities in the meridional plane of a centritugal compressor. This program will determine the velocities in the meridional plane of a backward-swept impeller, a radial impeller, and a vaned diffuser. The velocity gradient equation with the assumption of a hub-toshroud mean stream surface is solved along arbitrary quasi-orthogonals in the meridional plane. These quasiorthogonals are fixed straight lines that remain fixed, regardless of any streamline change. If the streamlines are not smooth, a smoothing routine can be used, increased interest has been shown in high pressure ratio backward swept centrifugal impellar blades because centrifugal compressors with such blades have the potential of achieving higher efficiencies than those with radial impeller blades Several methods are available for designing radial bladed compressors, but only limited work has been done on backward swept impeller blades The input quantities consist essentially of mass flow, rotational speed, number of blades, specific-heat ratio, inlet total temperature and density, gas constant, loss in total relative pressure, hub-to shroud profile, mean blade shape, and a normal thickness table. In the input, each item has units specified in both the SI and US customary systems. Since the program does not use any constants which depend on the system of units being used, any consistent set of units may be employed.

LANGUAGE: FORTRAN IV.
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,264 source statements
PRICE: Program \$590.00 Documentation \$6.50
PROGRAM NUMBER: LEW-11796

Computer Program for Preliminary Design Analysis of Axial Flow Turbines

A computer program has been developed for the preliminary design analysis of axial flow turbines. The computations are based on mean-diameter flow properties and do not consider any radial gradients. Specific heat ratio is assumed constant throughout the turbine. For any given turbine, all stages, except the first, are specified to have the same shape velocity diagram. The first stage differs only in that the infet flow is axial. The velocity

diagram shape depends upon the speed-work parameter value and the specified type of velocity diagram. Any of three types of velocity diagrams can be specified: symmetrical, zero exit swirt, or impulse. Exit turning vanes can be included in the design. Input design requirements include power or pressure ratio, mass flow rate, inlet temperature and pressure, and rotative speed. The design variables include inlet and exit diameters, stator angle or exit radius ratio, and number of stages. Gas properties are input as gas constant, specified heat ratio, and viscosity. The program output includes inlet and exit annulus dimensions, exit temperature and pressure, total and static efficiencies, blading angles, and last stage critical velocity ratios. Program verification by COSMIC was limited to compilation and link-edit on an IBM-7094

LANGUAGE: FOPRTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 598 source statements
PRICE: Program \$370.00 Documentation \$6.50
PROGRAM NUMBER: LEW-11815

Computer Program for Calculating Potential Flow in Propulsion System Inlets

In the process of designing inlets, particularly for Vertical Takeoff and Landing and Short Takeoff and Landing propulsion systems, a system of three computer programs evolved. The chief program is an axisymmetric potential flow program which calculates the incompressible potential flow about arbitrary axisymmetric bodies. One generates input from various specified analytic shapes for the inlet components. The other program takes basic solutions of interest and applies a compressibility correction.

LANGUAGE, FORTRAN IV (94%), MAP (6%)
PROGRAM REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 7,083 source statements
PRICE: Program \$630.00 Documentation \$15.00
PROGRAM NUMBER: LEW-12152

Computer Program for Definition of Transonic Axial-Flow Compressor Blade Rows

A computer program for designing axial flow compressor blading from stacked blade elements has been developed. The particular type of blade element used has two segments which have centerlines and surfaces described by constant change of angle with path distance on a cone. The computer program begins with input from velocity diagrams for stations near the leading and trailing edges of the blade and parameters for blade-element description. The blade design steps are: (I) blade-element definition, (2) blade-element stacking, (3) interfacing the reference station velocity diagrams to the blade-element edges, and (4) terminal calculations. The first three parts are used in an iterative procedure to establish the blade for terminal calculations. Clade-element angles are obtained from the velocity diagrams by (1) correcting the velocity diagrams from fixed locations to the edges of the blades through continuity and conservation of angular momen tum principles as stacking adjustments move the blade edges, (2) determining and applying incidence and deviation angles at the edges of the blade with one of several common methods chosen through control options, and (3) correcting the inlet and outlet blade edge angles on a streamline of revolution to the blade element layout cone with the use of appropriate direction derivatives. The iterative stacking adjustments are made by translating the blade elements along the cone so that the center of area of the associated blade section is alined on the stacking axis. The stacking axis through input controls can be leaned in either the axial or tangential directions. The output of the computer program gives coordinates for fabrication and properties for aeroelastic analysis on planar blade section. These coordinates and properties are defined by interpolation across conical blade elements to planes perpendicular to radial line through the hub stacking point. The output blade-section properties are area, center-of-area location, stackit.g-point location, maximum and minimum moments of inertia along with their orientation, torsion constant, and twist stiffness.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360 PROGRAM SIZE: Approximately 3,523 sou ce statements PRICE: Program \$350.00 Documentation \$19.00 Documentation \$19.00

PROGRAM NUMBER: LEW-12325

Stanton Number - Aerodynamic Heating

This desk-top procedure calculates the Stanton Numbers corresponding to specified flow conditions and configurations in the rarefaction regime. The solutions are valid for 3-D stagnation wedge/cylinder flows, cone/ogive flows, yawed-cylinder flows, flat plate flows and all combinations of the models (ogive for instance) dependent only upon selection of the proper option within the program provided. First and second order boundary conditions, where continuum and free molecular flow regimes are defined, are satisfied and accounted for in the program. The curve fits of experimental data -pproduce the polynomials that generate the Stanton Number variations. In the non-continuum regime, the Stanton Number is given as a function of a newly developed rarefaction coefficient, W, that combines the Mach number, Reynolds Number, compressibility factor, and Knudsen number.

LANGUAGE: Instructions and data are entered at the time of processing.

MACHINE REQUIREMENTS: Hewlett Packard 9820A PROGRAM SIZE: Not Applicable

PRICE: \$25.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: MSC-19493

AIRCRAFT

Includes aircraft design, testing, and performance; aircraft communication and navigation; aircraft instrumentation, aircraft propulsion systems; aircraft stability and control.

Aircraft Noise Source and Contour Estimation Computer Program

This computer system was developed for 1/3 octave band noise estimates for quiet engines, lift fans, lift/cruise fans, propellars and helicopters in addition to conventional jet engines. It also has the capability of computing noise contours (footprints). The system was written as two programs, one for providing source noise estimates for an aircraft operating at a prescribed set of conditions and the second to compute noise contours for an aircraft during takeoff or landing operations.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 10.768 source statements
PRICE: Program \$1.420 00 Documentation \$32 00
PROGRAM NUMBER: ARC-10380

Prediction of Stall Characteristics of Straight Wing Aircraft

The objective of this computer program is to calculate the span-wise distributions of lift, drag, and pitching moment coefficients on a wing-fuselage combination up to the angle of attack at which stall occurs and to predict the spanwise position of initial stall. The program considers an unswept wing with a circular or elliptical fuselage. The wing may have part or full span deflected flaps, and the wirig aspect ratio must be 6 or greater. For a wing without fuselage the litting line method of Sivells (NACA TR 1090) is employed. When a fuselage is present the method of Multhopp (NACA TM 1036) is used to transform the wingfuselage combination into an equivalent wing alone configuration. Lifting line theory, which is then applied to this transformed configuration, employs two-dimensional, experimental airfoil characteristics to obtain the lift, drag, and pitching moment coefficients at each station on the wing span. For a selected value of fuselage angle-of-attack, an approximate distribution of section lift coefficient is assumed. This distribution is then used to calculate the section angles of attack at each spanwise station on the wing. From curves of experimental section lift versus angle-of-attack, new values of section lift are obtained and compared with the initial values. Using the differences between initial and calculated values, a new and better approximation to the lift distribution is calculated. An iterative procedure is then employed until the guessed and calculated values agree. Once the correct lift distribution is established, the distributions of drag and pitching moment are obtained from the curves of experimental twodimensional airfoil section characteristics. Spanwise integration of the lift, drag, and pitching moment distributions yield the overall wing lift, drag, and pitching moment, respectively. If calculations are made at a sufficiently high value of fuselage angle-of-attack a point on the span will be reached where the local angle-of-attack equals or exceeds the angle of-attack for maximum lift as determined from the two-dimensional section data. When this occurs the wing is said to stall. Thus the method can be used to predict the spanwise location of initial stall on the wings of wing-fuselage combinations.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 series
PROGRAM SIZE: Approximately 10,295 source statements
PRICE: Program \$370.00 Documentation: \$22.50
PROGRAM NUMBER: LAR-11013

Theoretical Prediction of Interference Loading on Aircraft

A method is developed for theoretically predicting the localing on pylon mounted stores in subsonic compressible flow. Linear theory is used, without two-dimensional or slender body assumptions, to predict the flow field produced by the aircraft wing, nose, inlet, and pylons. The interference loading is integrated over the store length by considering the local crossflow, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach. 8 are compared to wind tunnel data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 series
PROGRAM SIZE: Approximately 1.600 source statements
PRICE: Program \$590.00 Documentation \$22.00
PROGRAM NUMBER: LAR-11249

Theoretical Prediction of Interierence Loading on Aircraft Stores - Supersonic Case

A program was developed for theoretically predicting the loading on pylon-mounted stores in supersonic flow. Linear theory is used, without two-dimensional or slender body assumptions, to predict the flow field produced by the aircraft wing, nose, inlet, and pylons. Aircraft shock wave locations are predicted, and their effect on the flow field is included through a transformation of the aircraft geometry. The interference loading is integrated over the

store length by considering the local crossflows, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach 1.2 are compared to wind tunnel data. The method is computerized, and program user information is included. A companion report presents the method in subsonic flow.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 2,310 source statements
PRICE: Program \$700.00 Documentation \$21.50
PROGRAM NUMBER: LAR-11250

An Improved Method for Design of Expansion Chamber Mufflers with Application to an Operational Helicopter

An improved method for the design of expansionchanaber mufflers for reciprocating engines is described and applied to the task of reducing exhaust noise generated by a helicopter. The method is an improvement of standard transmission line theory in that it accounts for the effectof the mean exhaust-gas flow on the acoustictransmission properties of muffler system, including the termination boundary condition. The method has been computerized, and the computer program includes an optimization procedure that adjusts muffler component lengths to achieve a minimum specified desired transmission loss over a specified frequency range. A field test of a muffler designed with the aid of this method was conducted on a helicopter (H130 with a known exhaustnoise problem. When the exhaust noises of the helicopter with a standard exhaust system and a similar helicopter with a muffler system installed were compared for hover flight conditions, the muffler system was found to reduce the exhaust noise by approximately 11 dB ?A). No significant degradation in the engine performance was observed.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS, CDC 6000 series
PROGRAM SIZE: Approximately 817 source statements
PRICE: Program \$350.00 Documentation \$10.00
PROGRAM NUMBER: LAR-11548

Computer Program for Design Point Performance of Turbojet and Turbofan Engine Cycles

This program is one designed for the calculation of design-point performance of turbojet and turbofan engine cycles. This program requires as input the airplane Mach number, the altitude-state equations, turbine-inlet temperature, afterburier temperature, duct-burner temperature, bypass ratio, coolant flow, component efficiencies, and component pressure ratios. The output yields specific thrust, specific fuel consumption, engine efficiency, and several component temperatures and pressures. The thermodynamic properties of the gas are expressed as functions of temperature and fuel to-air ratio. The program is provided with an example case.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 370 source statements
PRICE: Program \$250.00 Documentation \$7.50
PROGRAM NUMBER: LEVI-10952

Analysis of Jet Engine Burst Rotor Containment Devices

The turbojet engine in wide use today has proven itself to be the most reliable and trouble-free aircraft engine in the

history of aviation. Yet, the uncontained failure of highspeed rotating turbojet engine parts, due either to an undiscovered fault in the engine, or catastrophic ingestion of foreign matter, is a well-documented problem. The possibility of just one commercial airliner crashing because of an uncontained engine failure is sufficient incentive to search for a solution to the problem. A computer program (JETI) has been developed to predict the large two-dimensional elastic-plastic dynamic deformations of a free, non-uniformly heated circular ring subjected to an initial impulse loading followed by a timedependent forcing function which could be defined to simulate the forces which result from the interaction of a burst-rotor blade and a containment ring. Provisions which account for temperature-dependent material properties and effects of temperature-induced thermal stresses are included. Temperature dependent, strain hardening, and strain-rate effects of the ring material are taken into account. A new method which uses measured ring position data obtained from high-speed motion picture film is proposed to calculate the approximate "external forces" acting on the ring caused by a fragment-ring interaction. The required accuracy in position measurements to obtain meaningful forces is presented together with resulting example forces.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1.491 source statements
PRICE: Program: \$590.00 Documentation. \$17.50
PROGRAM NUMBER: LEW-11339

Computer Programs for Predicting Turbopump Inducer Loading, Stress Magnitude, Distribution and Vibration Characteristics

Inducers are widely used in rocket engine turbopumps to prevent cavitation in the pump main stages, thereby, permitting higher turbopump operating speeds and/or reduced pump inlet pressure. In the design of an inducer, hydrodynamic performance can be accurately predicted from empirical loss and deviation data. The prediction of operating stresses presents a problem, however, because (1) there is a lack of information on blade pressure loading and (2) the complexity of the inducer blade shape prevents simple steady and vibratory stress analysis. Consequently, inducer mechanical design is usually based on several approximations, with liberal safety factors being applied. This approach results in relatively heavy inducers with undesirably thick blades. Three computer programs have been developed for the prediction of (1) design and off design hydrodynamic blade loading under cavitating and non-cavitating conditions, (2) blade stresses due to hydrodynamic and centrifugal loading, and (3) blade resonant frequencies and relative stress distribution for turbopump inducers. The hydrodynamic computer program predicts internal flow conditions and blade pressure loadings within an inducer. The input can be divided into two parts: (1) A geometric description of the inducers; and (2) a description of the inducer operating flow parameters More than one set of flow parameters may be input for a given inducer geometry. The stress computer program breaks the inducer blade into flat triangular elements for analysis. The program then calculates stress magnitude and distribution caused by pressure loading and centrifigal force using the matrix displacement method. Input to the stress program generally consists of: A physical description of the inducer, a description of the finite

store length by considering the local crossfiows, its axial and radial derivatives, and buoyancy. Store moment calculations under an F-4 aircraft at Mach 1.2 are compared to wind tunnel data. The method is computerized, and program user information is included. A companion report presents the method in subsonic flow.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 2,310 source statements
PRICE: Program \$700.00 Documentation \$21.50
PROGRAM NUMBER: LAR-11250

An Improved Method for Design of Expansion Chamber Mufflers with Application to an Operational Halicopter

An improved method for the design of expansionchaniber muttlers for reciprocating engines is described and applied to the task of reducing exhaust noise generated by a helicopter. The method is an improvement of standard transmission line theory in that it accounts for the effectof the mean exhaust-gas flow on the acoustictransmission properties of muffler system, including the termination boundary condition. The method has been computerized, and the computer program includes an optimization procedure that adjusts muffler component lengths to achieve a minimum specified desired transmission loss over a specified frequency range. A field test of a muffler designed with the aid of this method was conducted on a helicopter (H130 with a known exhaustnoise problem. When the exhaust noises of the helicopter with a standard exhaust system and a similar helicopter with a muffler system installed were compared for hover flight conditions, the muffler system was found to reduce the exhaust noise by approximately 11 dB ?A). No significant degradation in the engine performance was

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 series
PROGRAM SIZE: Approximately 817 source statements
PRICE: Program \$350.00 Documentation \$10.00
PROGRAM NUMBER: LAR-11548

Computer Program for Design Point Performance of Turbojet and Turbofan Engine Cycles

This program is one designed for the calculation of design-point performance of turbojet and turbofan engine cycles. This program requires as input the airplane Mach number, the allitude-state equations, turbine-inlet temperature, afterburier temperature, duct burner temperature, bypass ratio, coolant flow, component efficiencies, and component pressure ratios. The output yields specific thrust, specific fuel consumption, engine efficiency, and several component temperatures and pressures. The thermodynamic properties of the gas are expressed as functions of temperature and fuel to-air ratio. The program is provided with an example case.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 370 source statements
PRICE: Program \$250.00
PROGRAM NUMBER: LEW-10952

Analysis of Jet Engine Burst Rotor Containment Devices

The turbojet engine in wide use today has proven itself to be the most reliable and trouble free aircraft engine in the

history of aviation. Yet, the uncontained failure of highspeed rotating turbojet engine parts, due either to an undiscovered fault in the engine, or catastrophic ingestion of foreign matter, is a well-documented problem. The possibility of just one commercial airliner crashing because of an uncontained engine failure is sufficient incentive to search for a solution to the problem. A computer program (JETI) has been developed to predict the large two-dimensional elastic-plastic dynamic deformations of a free, non-uniformly heated circular ring subjected to an initial impulse loading followed by a timedependent forcing function which could be defined to simulate the forces which result from the interaction of a burst-rotor blade and a containment ring. Provisions which account for temperature-dependent material properties and effects of temperature-induced thermal stresses are included. Temperature-dependent, strain-hardening, and strain-rate effects of the ring material are taken into account. A new method which uses measured ring position data obtained from high-speed motion picture film is proposed to calculate the approximate "external forces" acting on the ring caused by a fragment-ring interaction. The required accuracy in position measurements to obtain meaningful forces is presented together with resulting example forces.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,491 source statements
PRICE: Program: \$590.00 Documentation: \$17.50
PROGRAM NUMBER: LEV-11389

Computer Programs for Predicting Turbopump Inducer Loading, Stress Magnitude, Distribution and Vibration Characteristics

Inducers are widely used in rocket engine turbopumps to prevent cavitation in the pump main stages, thereby, permitting higher turbopump operating speeds and/or reduced pump inlet pressure. In the design of an inducer, hydrodynamic performance can be accurately predicted from empirical loss and deviation data. The prediction of operating stresses presents a problem, however, because (1) there is a tack of information on blade pressure loading and (2) the complexity of the inducer blade shape prevents simple steady and vibratory stress analysis Consequently, inducer mechanical design is usually based on several approximations, with liberal safety factors being applied. This approach results in relatively heavy inducers with undesirably thick blades. Three computer programs have been developed for the prediction of (1) design and off design hydrodynamic blade loading under cavitating and non-cavitating conditions, (2) blade stresses due to hydrodynamic and centrifugal loading, and (3) blade resonant frequencies and relative stress distribution for furbopump inducers. The hydrodynamic computer program predicts internal flow conditions and blade pressure loadings within an inducer. The input can be divided into two parts (1) A geometric description of the inducers; and (2) a description of the inducer operating flow parameters. More than one set of flow parameters may be input for a given inducer geometry. The stress computer program breaks the inducer blade into flat triangular elements for analysis. The program then calculates stress magnitude and distribution caused by pressure loading and centrifigal force using the matrix displacement method. Input to the stress program generally consists of. A physical description of the inducer, a description of the finite element breakup to be used, and a description of the blade pressure distribution. The vibration computer program is a finite element analysis which uses many of the same subroutines as the stress program. This program calculates natural frequencies and the distribution of relative displacement and stress for each resonant frequency, Input to this program generally consists of: A physical description of the inducer, a description of the finite element breakup to be used, and a specification of the number of vibratory nodes required.

LANGUAGE: FORTRAN G (95.6%); ASSEMBLER (4.4%) MACHINE REQUIREMENTS: IBM-360 PROGRAM SIZE: Approximately 5,847 source statements PRICE: Program \$950.00 Documentation \$43.50 PROGRAM NUMBER: LEW-11516

Computer Programs for Handling Propulsion System Hoise Data

This is a system programs which deals with a variety of noise data reduction and analysis tasks. The data under consideration are 1/3 octave band spectra obtained from multiple far field angular microphone positions about a source. The central program (WODAG, for WOrking DAta Generation) takes raw measured data arrays, corrects them for atmospheric absorption for the test conditions and computes the source emission characteristics. These include the overall acoustis power level, the power spectrum and directivity index for each frequency. Standard day atmospheric absorptions are computed, and the data is extrapolated to various distances for which perceived noise levels are also computed. Of particular importance are the source emission characteristics which, in addition to their intrinsic value, are punched into a set of cards called working data which contain all the information necessary to reconstruct the acoustic field data.

Retained by users, and in conjunction with other programs which are given, they provide non-programmers with comprehensive data manipulation and analysis capability. Many commen computational tasks are relegated to subroutines permitting the user having special needs to easily program ordinary tasks and to concentrate on the special requirements.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,833 source statements
PRICE: Program \$200.00 Documentation \$8.00
PROGRAM RUMBER: LEW-12255

LAGLOP Landing Gear Loads Program

A computer program has been developed to compute landing gear grd indirection loads to be used for airplane-type landing gear. The program is written for the analysis of conventional airplane-type wheel-tire landing gear configurations consisting of a single nose gear and two main gears. When a gear consists of a roultiple wheel assembly, the loads computed for that gear are divided equally among the wheels. The loads consist of vertical, drag, and lateral loads applied at the ground. The exceptions are the drag loads for the landing spin up and springback conditions which are applied at the axle. Input data consists of the vehicle weight, center of gravity, location, main and nose gear location, and the gear factor. Output consists of tabulation of vertical, drag, and lateral loads or the nose and main gear.

LANGUAGE: FORTRAN IV
MACHI-LE REQUIREMENTS: IBM-360
PROGPAM SIZE: Approximately 279 source statements
PRICE: Program \$160.00
PROGRAM NUMBER: MSC-17572

AUXILIARY SYSTEMS

Includes auxiliary power sources such as chemical power units, fission electric cells, nuclear power units, electric batteries, electric generators, and solar power units; auxiliary gas turbines; hydraulic, pneumatic and electrical systems.

POSIMO—Power System Simulator Model

The power system is considered to be a group of both power consuming or power donating power elements. Each element may be either a passive load or a load which may serve as a source for subsequent connected loads. The numerous combinations in which such a set of power elements can interact to form a particular power system can be expressed in terms of kind and number of serial and parallel interconnections between these elements, while the various power flow configurations in any such power system are determined on the one side of the 2n combinations of the N status indicators and on the order side by the power dependant response of the sources involved. The analysis of the power element combinations to a particular power system is performed by program POSIMO PREParation while the calculation of the different power flow configurations and their inherant power balance and charge budget response is done by POSIMO EXECution. POSIMO PREP will generate the required data set for POSIMO EXEC from three different sources of input: 1. a load - source - assignment list, 2. a load - status assignment list and 3. a set of coordinates denoting the efficiency vs. power response of the different sources. The outstanding feature of the approach lies in the simplicity of the lists to be entered, inasmuch as any list item refers to only one seperate power element disregarding its connections and impacts on any of the remaining elements of the system. The first list simply states how much power from which response to which of the power elements is received or submitted. The second list is simply represented by the Boolean expressions of status indicators for each power element. Both the sequence of element names appearing in the two lists and the status indicators in the Boolean expressions may be written in random order. Usually one parameter (the nominal power) will be sufficient to describe the power property of a single power element. For increased flexibility; however, POSIMO is prepared to take up to 3 power parameters along with one parameter processing designator. If more than one parameter shall be employed, the user can easily insert his own processing routines. Basically, POSIMO can handle power systems of any extent and configuration if they can be described by the three input sources as mentioned above. Limits due to reasonable array dimensions have been introduced into POSIMO for power systems considered to be sufficiently extensive and comprising up to 200 elements, 50 of which may be both loads and sources and up to 10 sources in series. The power systems may be controlled by up to 100 status indicators which may be combined in Boolean expressions with up to 8 ANDs and 8 ORs.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 1,131 source statements PRICE: Program \$560 00 Documentation \$11.00

PROGRAM NUMBER: GSC-11505

Transformer Optimization Program

A computer program has been developed for performing transformer optimization. In using this program, values of flux density, frequency, primary and secondary voltage and current, materials constants, and input volts per turn ratio must be known or assumed. Given these parameters, the program computes: (1) primary and secondary turns, resistance, length of windings and losses; (2) core size, volume, weight and losses; (3) voltage regulation; and (4) overall transformer efficiency. The output tabulation consists of the computed results versus volts per turn ratio. Since frequency and flux density are not included in the transformer optimization routine, the program is not complete. In its present condition, it would make a good supportant.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 223 source statements
PRICE: Program \$140.00 Documentation \$19.50
PROGRAM NUMBER: LEW-10299

ESATA—Executive Subroutines for Afterheat Temperature Analysis of a Mobile Gas Cooled Nuclear Reactor

The ESATA computer program has been developed to analyze the thermal safety aspects of post-impacted mobile nuclear power plants. The program calculates the transient temperature and pressure response for a gascooled thermal reactor power plant following impact. The analysis is based on a closed containment vessel system

with trapped helium gas where the nuclear afterheat must be dissipated by conduction through the containment wall without exceeding the creep-rupture strength of the containment vessel. In addition to the heat transfer mechanisms of conduction, convection, and radiation, phenomena such as core and shield melting and displace ment, fission product release from the reactor core and shield melting and displacement, fission product release from the reactor core followed by subsequent condensation and re-evaporation, metal-water chemical reactions, and pressure buildup due to increased temperatures and volatile products are simulated. Flexibility was built into the program to consider variable core, shield, and containment vessel dimensions, variable weight, initial temperatures and several shield options. In addition to the problem described, one option of the program permits solution of problems involving transient or steady state heat transfer in multi-dimensional systems having arbitrary geometric configurations, boundary conditions, initial conditions, and physical properties. The program can be extended to analyze mobile power plant concepts utilizing reactor concepts such as the liquid metal cooled fast reactor. In addition, the program could be extended to perform meltdown analysis of stationary power plants or analysis of post impacted fuel capsules following re-entry.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/7044
PROGRAM SIZE: Approximately 6,551 source statements
PRICE: Program \$680.00 Documentation \$28.50
PROGRAM NUMBER: LEW-11693

SESOP - Program for Solar Energy Heating Systems Analysis

This program deals with energy conservation and contains thirteen subroutines for the analysis of heating,

ventilation and air conditioning systems with solar energy utilization for space heating and hot water heating. Operations performed by the program include: (1) Calculation of the hot water demand profiles. (2) Calculation of the space heating and cooling loads. (3) Calculation of the electric demands. (4) Analysis of flat plate non-tracking solar collectors and calculation of the energy collected by the solar collectors. (5) Calculation of the purchased energy requirements (electricity, fuel oil and natural gas) of the heating, ventilation and air conditioning system, as well as, water and electricity utility systems. (6) Comparison of the energy requirements of the conventional systems and the solar energy systems: Hot water demand profiles are calculated by use of empirical equations with the number of occupants per dwelling unit and the number of dwelling units being the independent variables. The space heating and cooling loads are calculated for each building based on outside environment, desired inside conditions, building construction and geometry, domestic power usage, occupancy rate and occupant metabolic rate. Upon completion of calculation of the loads for each of the buildings, the loads are summed to determine the requirements of the central utility systems. Based upon input descriptions of the environment and the solar collectors, an analysis is performed to determine a profile of the amount of useful energy which can be collected by the solar collectors. The program uses the load profiles and solar energy profiles to determine the energy required by alternative systems to meet the utility demands

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series, Exec 8
PROGRAM SIZE: Approximately 2.296 source statements
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR Formatted Tape
PRICE: Program \$530.00 Documentation \$10.50
PROGRAM RUMBER: MSC-14853

1

BIOTECHNOLOGY

Includes life support systems; bioengineering (bioinstrumentation, biometrics, biotelemetry, cardiography, electroencephalography); personnel training, evaluation, and maintenance (medical).

Veterans Administration Automated ECG Analysis System, CDC 3000 Series Version

This program was designed and written to assist in the automatic analysis and diagnostic classification of electrocardiographic (ECG) data. The analysis performed consists primarily of three general phases: (1) Pattern recognition of individual beats and their component wave forms. The purposes of pattern recognition are to locate noise spikes in the ECG input data, to locate the heart cycles within the input record and to locate the beginnings and ends of wave forms within each beat. (2) Calculation of measurements on the recognized beats and analysis. The measurement analysis performs four interrelated functions, single lead wave form analysis, calculation of the set of discriptive measurements on each recognized beat, measurement selection and averaging, and a beat-tobeat analysis for rhythm determination. (3) Diagnostic classification of the record. This diagnostic classification performs measurement modification, diagnostic classification for conduction defects, diagnostic classification based on QRS and ST-T measurements, diagnostic classification based on P wave measurement and diagnosis of ventricular strain and wall injury based on ST-T measurements. Estimated error rates are given in the form of misclassification matrices, computed from large numbers of tracings, where the correct diagnoses were taken from clinical, laboratory and autopsy information.

LANGUAGE: FORTRAN IV (99%); ASSEMBLER (1%) MACHINE R°QUIREMENTS: CDC-3200, MSOS version 4.0 PROGRAM > 1ZE: Approximately 6,250 source statements PRICE: Program \$810.00 Documentation \$19.00 PROGRAM NUMBER: COS-02450

Veterans Administration Automated ECG Analysis System, Varian 73 Version

This program was designed and written to assist in the automatic analysis and diagnostic classification of electrocardiographic (ECG) data. The analysis performed consists primarily of three general phases: (1) Pattern recognition of individual beats and their component wave forms. The purposes of pattern recognition are to locate noises spikes in the ECG input data, to locate the heart cycles within the input record and to locate the beginnings and ends of wave forms within each beat. Calculation of

measurements on the recognized beats and analysis. The measurement analysis performs four interrelated functions, single lead wave form analysis, calculation of the set of descriptive measurements on each recognized beat, measurement selection and averaging, and a beat-to-beat analysis for rhythm determination. (3) Diagnostic classification of the record. This diagnostic classification performs measurement modification, diagnostic classification for conduction defects, diagnostic classification based on QRS and ST-T measurements, diagnostic classification based on P wave measurement and diagnosis of ventricular strain and wall injury based on ST-T measurements. Estimated error rates are given in the form of misclassification matrices, computed from large numbers of tracings, where the correct diagnoses were taken from clinical, laboratory and autopsy information.

LANGUAGE: FORTRAN IV (89%): ASSEMBLER (11%)
MACHINE REQUIREMENTS: VARIAN 73
PROGRAM SIZE: Approximately 7,656 source statements
PRICE: Program \$810.00 Cocumentation \$17.00
PROGRAM NUMBER: COS-02451

MIMS --- Medical Information Management System

The Medical Management Information System (MIMS) was developed to handle all aspects of data related to patient care. Its prime benefits are (1) the ability to recall a record of a specific patient in a matter of seconds, (2) to search for specific types of data among patient records, and (3) the ability to do medical research with a readily available data base. The flexibility of the system allows the user to (1) decide the categories of data, (2) decide on the format of the data, (3) change any data entry without regard to the length of the original data field, (4) retrieve any selected item of data or all of the data. (5) generate tabular information assembled from the comparison of all the records in the system, and (6) generate statistical information, MIMS provides an efficient method of flexible and complete data retrieval.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 4,000 source statements
PRICE: Program \$720.00 Documentation \$15.50
PROGRAM NUMBER: GSC-11540

Proton Tissue Dose for the Blood Forming Organ in Human Geometry: Isotropic Radiation

This program contains seventeen subroutines and calculates proton dose averaged over the limbs, trunk, and skull of the blood forming organ. The program was written to calculate the anticipated dose distribution in the human body in the radiation environment encountered in radiation shield and dosimeter design, and for space mission analysis. Usually the human body is approximated by simple geometries such as a sphere, slab, or cylinder, with resultant disagreement among the various approximations and consequent disagreement on shield and dosimeter design and undesirable impact on mission objectives. However, this program treats human body geometry in detail. The program calculates the areal density distribution function, fluence-to-dose conversion factors, and incident fluence spectrum. These functions are integrated to give an intermediate function which in turn is used in the integration of the dosage parameter. The result is always a conservative estimate of dose and is given as physical dose and dose equivalent. Although originally programmed on a 60-bit machine, round-off error on shorter word machines should not be a problem for these calculations.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 554 source statements
PRICE: Program \$330.00 Documentation \$2.50
PROGRAM NUMBER: LAR-11802

Metabolic Balance Analysis Program

This program calculates body metabolic energy availability, oxygen and water requirements, body wastes production, and total packaged food weight requirements for space missions. These data have been estimated in the past. These past estimates have, of necessity, been very conservative and have resulted in excessive design requirements for consumables. Because of critical weight limitations on most space missions, the need existed for a more accurate determination of consumables requirements and wastes production. This program could be useful in determining or evaluating diets for hospital patients. Also, the program would be applicable to determining food and water requirements for military or industrial groups working in isolated, remote areas.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6500
PROGRAM SIZE: Approximately 477 source statements
PRICE: Program \$340.00
Documentation \$5.50
PROGRAM NUMBER: MFS-21237

VECTAN II: A Computer Program for the Analysis of Vectorcardiograms

VECTAN II is designed to analyze vectorcardiographic (VCG) data from normal individuals during rest and controlled orthostatic stress procedures. The program accepts as input digitized three lead Frank VCG data sampled at 320 samples/second/lead, analyzing one VCG complex in each five second interval for experiments of up to 25 minutes duration. The program calibrates these data, locates the three major waveforms (P-wave, QRS complex, and T-wave), performs waveform analyses and produces a statistical summary of the analyzed data. The waveform recognition technique employed to find the beginning and end points of the three basic waveforms uses the VCG spatial vector length rather than its derivative to reduce the

effects of high frequency noise and to eliminate sensitivity to differences in waveform location among the three leads. The waveform analysis is designed to give the minimum number of parameters that fully characterize an individual's response to a stress protocol. These analyses utilize the eigenloop concept to characterize the three dimensional vector loops of the QRS and T waves with the results including the eigenloop area, circumference, depth and orientation angles as well as fractional circumference vector parameters characteristic of the eigenloop shape. Conventional parameters such as ventricular gradient, Jjunction offset, ST segment slope, and waveform temporal measurements are also produced. Because VECTAN is designed to measure VCG variations in normal subjects, no diagnostic options are included. For VCG analysis precedures designed for use in a clinical setting with diagnostic options refer to program numbers COS-02450, COS-02451, and COS-02452.

LANGUAGE: FORTRAN V (98%), UNIVAC Assembler (2%) MACHINE REQUIREMENTS: UNIVAC 1108 (EXEC II - Monitor) SC-4060 Microfilm Recorder PROGRAM SIZE: Approximately 2,095 source statements DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape PRICE: Program \$490.00 Documentation \$27.50 PROGRAM NUMBER: MSC-14385

Nutritional Evaluation of Diets

Evaluation of the diet of people (or animals and plants) is important in understanding their health. However: 1) The complete list of nutritionally important food components (vitamins, minerals, fatty acids, amino acids, etc.) is lengthy and easily exceeds 50 items; 2) A person's diet may contain one to two dozen different foods; 3) These foods may be measured in a variety of units; and 4) The recommended nutritional levels of food are a function of sex, age, and, in some cases, special dietary considerations. These four items entail a considerable amount of work by anyone trying to evaluate diets by hand computations. Some of the computer programs designed to solve this problem do not handle the full range of nutrients. This program solves the above problems. This program has been designed to handle lengthy lists of nutritional recommendations (up to 100) and still provide a neat, readable, and complete list of the results. The program also computes the cost of the amount of food used in the diet. The program interconverts units so that the units of measure of a particular food can be referred to as cups in one run, grams in the next, pounds in a third run, and ounces in a fourth run. Thus, if a diet card states that a person ate "% each" of a medium sized banana that cost \$0.25 for 2 pounds, the program would compute the cost of that half a banana and the nutritional value in it. If one knew the weight or mass of the banana (in ounces, pounds, or grams) then that quantity and that unit could be entered instead of "15 each." The program has a table of recommended nutritional values, which is a function of age, sex, pregnancy and lactation, and, for infants, is also a function of infant weight. For special dietary considerations, any (or all) of the standard recommendations can be easily modified to any desired value. The program, as presently written, can handle up to 100 different foods (and 100 nutrients per food). If more disk space were available, a trivial program modification would allow the handling of more foods. The "program" is very modular to simplify making changes. It actually consists of four seperate programs. Three of he programs set up the basic date and are run infrequently. The fourth program (the Analysis Program) performs the diet analysis. This Analysis Program consists of the main program and three subroutines. Again, the concept was to keep the Analysis Program itself modular in order to simplify making changes.

tANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-1130
PROGRAM SIZE: Approximately 600 source statements
PRICE: Program \$390 00 Documentation \$9.00
PROGRAM NUMBER: NPO-13205

CHEMISTRY

Includes chemical analysis and identification, chemical engineering, electrochemistry, inorganic and physical chemistry.

Qualitative and Quantitative Analysis of Low Resolution filess Spectra Computer Pregram

This program was written to determine the precise gas constituents from an analysis of low resolution mass spectra. The documentation includes the analysis technique; preparation of the reference-library mass spectra; preparation of the mass spectrum of the gas mixture to be analysed; a sample problem, with interpretation of the analysis results; and instructions for use of the computer program. Applications for this program include gas analysis for work in space environmental simulators, space environment, and air pollution monitoring.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 844 source statements
PRICE: Program \$380.00 Documentation \$10.00
PROGRAM NUMBER: GSC-11279

Chemical Equilibrium of Ablation Materials Including Condensed Species

This program package consists of a computer program which calculates chemical equilibrium compositions of ablation materials over a range of temperatures. It has been used for pyrolysis products of phenolic nylon at temperatures from 500-3500°K, but may be used to calculate multiphase chemical equilibrium compositions of arbitrary systems. It differs from most programs of this type by including condensed species as well as gaseous species in the calculations. The program can accept 90 gaseous species and 10 condensed species at one time. Equilibrium is determined by finding the minimum free energy using the method of steepest descent applied to a quadratic representation of the free energy surface. The program has been shown to be accurate by the comparison of computer solutions to exact solutions for simple reacting systems, also compilier programming logic has been used which results in good computing speed. The program is written entirely in FORTRAN IV to operate in batch mode and presently runs on CDC Series machines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 656 source statements
PRICE: Program \$450.00 Documentation \$6.50
PROGRAM NUMBER: LAR-11801

General Chemical Kinetics Computer Program for Static and Flow Reactions with Application to Combustion and Shock Tube Kinetics

This program can be used for any homogeneous reaction in either one dimensional flow or a static system. It is flexible, accurate and easy to use. It can be used for any chemical system for which species thermodynamic data and reaction rate constant data are known The program handles several types of reactions: bimolecular exchange reactions, unimolecular decompositions, bimolecular decompositions and the reverse recombination process. An implicit numerical integration method is used for the solution of the differential equations that describe a complex reaction. A new step size optimization procedure has been developed to make this technique work efficiently for a wide range of conditions. This includes the extremes of very slow and very fast reactions. The program can be used to compute: (1) chemical reaction behind a shock wave, (2) ignition and combustion in a flowing or static system, (3) ignition, combustion, and nozzle expansion in supersonic flow, (4) chemical reaction in any flowing gas mixture whose velocity does not reach the speed of sound, (5) chemical reaction in any static system, and (6) constant temperature and/or constant volume reactions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7044/94 Direct-Couple
System (DCS)
PROGRAM SIZE: Approximately 5,625 including 2,038
data cards
PRICE: Program \$820.00 Documentation \$17.00
PROGRAM NUMBER: LEV-11467

ACE—Aerotherm Chemical Equilibrium Computer Program

The Aerotherm Chemical Equilibrium (ACE) computer program is an extremely versatile code for calculating quantities of importance to a broad variety of thermochemical processes. The thermochemical processes treated may be divided into two categories: closed systems and open systems. Closed systems are those for which the relative amounts of each chemical element in the system is prespecified. Open systems are those for which the relative amounts of chemical elements depend on various mass transfer rates due, for example, to boundary layer convection or solid surface degration. The ACE program

can treat both systems in chemical equilibrium and systems for which certain reactions are kinetically controlled

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 3,067 source statements
PRICE: Program \$720.00 Documentation \$16.00
PROGRAM NUMBER: LEV-11722

Computer Program for Calculation of Complex Chemical Equilibrium Compositions, Rocket Performance, Incident and Reflected Shocks, and Chapman-Jouguet Detonations

The knowledge of chemical equilibrium compositions of a chemical system permits calculation of theoretical thermodynamic properties of problems in chemistry and chemical engineering. Some applications are the design and analysis of equipment such as compressors, turbines, nozzles, engines, shock tubes, heat exchangers, and chemical processing equipment. This program has been developed to solve numerically, through the use of nonlinear algebraic equations, chemical equilibria in complex systems. A free minimization technique is used. The program permits calculations such as chemical equilibrium for the following assigned thermodynamic states: (1) Temperature and pressure; (2) Enthalpy and pressure; (3) Entropy and pressure; (4) Temperature and volume or density; (5) Internal energy and volume or density; and (6) Entropy and volume or density. Other problems capable of being calculated are: (1) Theoretical rocket performance; (2) Chapman-Jouget' detonations; and (3) Shock tube parameter calculations. The condition for equilibria may be stated in terms of any of several thermodynamic functions such as the minimization of the Gibbs free energy or Helmholtz free energy. If it is desired to use temperature and pressure to characterize a thermodynamic state, the Gibbs free energy is most easily minimized since temperature and pressure are its natural variables. Similarly, the Helmholtz free energy is most easily minimized if the thermodynamic state is characterized by temperature and volume (or density). Topics included in the complex equilibrium calculations are: mathematical analysis and techniques for obtaining chemical equilibrium; formulas for obtaining thermodynamic mixture properties and derivatives; criteria for

inclusion of condensed phases; calculations at a triple point, inclusion of ionized species; and applications.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,177 including 1,860 of
data
PRICE: Program \$630.00 Documentation \$22.00
PROGRAM NUMBER: LEW-11740

Three Bit Mass Spectral Search Program

The purpose of this program is to arrist the chemist in identifying low resolution mass spectra by means of a library search against a file of 6,880 mass spectra. For each unknown spectrum, the program provides a list of ten compounds in the library whose spectra are "closest" to the unknown by some goodness of fit criterion. Extensive testing of the program has shown it to be highly reliable and extremely rapid for pure compound and binary mixture identification. In the 3 bit library search, the peaks heights of both the unknown mass spectrum and the library spectrum are encoded to 3 bits, or 8 levels. At each nominal pass, the peak height is an integer 1, where 0=1=7. The transitions between levels have been set logrithmetically as a function of the percent total ion current. The maximum mass range covered in the search is amu 12-243. By means of data input, narrower mass ranges can be searched. By relatively simple coding changes, it is also possible to mask out certain masses or mass number ranges in the search. Two versions of the program, using approximately the same amount of core is available: (a) Up to 30 unknowns per pass through the library can be handled. No detailed side-by-side spectral summary is provided. (b) Up to 20 unknowns per pass can be handled. A detailed side by side spectral summary is provided at the conclusion of the program. In both programs, core requirements are roughly proportional to the maximum number of unknowns to be handled on each pass through the tape.

LANGUAGE: FORTRAN IV (98%); ASSEMBLER (2%)
MACHINE REQUIREMENTS: IBM-360/44 with 128K bytes
of core
PROGRAM SIZE: Approximately 7.821, including 6.832
data cards
PRICE: Program \$280.00 Documentation \$10.00
PROCRAM NUMBER: NPO-11960

can treat both systems in chemical equilibrium and systems for which certain reactions are kinetically controlled

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 3,067 source statements
PRICE: Program \$720.00 Documentation \$16.00
PROGRAM NUMBER: LEV-11722

Computer Program for Calculation of Complex Chemical Equilibrium Compositions, Rocket Performance, Incident and Roflected Shocks, and Chapman-Jouguet Dotonations

The knowledge of chemical equilibrium compositions of a chemical system permits calculation of theoretical thermodynamic properties of problems in chemistry and chemical engineering. Some applications are the design and analysis of equipment such as compressors, turbines, nozzles, engines, shock tubes, heat exchangers, and chemical processing equipment. This program has been developed to solve numerically, through the use of nonlinear algebraic equations, chemical equilibria in complex systems. A free minimization technique is used. The program permits calculations such as chemical equilibrium for the following assigned thermodynamic states: (1) Temperature and pressure; (2) Enthalpy and pressure; (3) Entropy and pressure; (4) Temperature and volume or density; (5) Internal energy and volume or density; and (6) Entropy and volume or density. Other problems capable of being calculated are: (1) Theoretical rocket performance: (2) Chapman-Jouget detonations; and (3) Shock tube parameter calculations. The condition for equilibria may be stated in terms of any of several thermodynamic functions such as the minimization of the Gibbs free energy or Helmholtz free energy. If it is desired to use temperature and pressure to characterize a thermodynamic state, the Gibbs free energy is most easily minimized since temperature and pressure are its natural variables. Similarly, the Helmholtz free energy is most easily minimized if the thermodynamic state is characterized by temperature and volume (or density). Topics included in the complex equilibrium calculations are: mathematical analysis and techniques for obtaining chemical equilibrium; formulas for obtaining thermodynamic mixture properties and derivatives; criteria for

inclusion of condensed phases; calculations at a triple point, inclusion of ionized species; and applications.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,177 including 1,860 of data
PRICE: Program \$630.00 Documentation \$22.00
PROGRAM NUMBER: LEV-11740

Three Bit Mass Spectral Search Program

The purpose of this program is to arrist the chemist in identifying low resolution mass spectra by means of a fibrary search against a file of 6,880 mass spectra. For each unknown spectrum, the program provides a list of ten compounds in the library whose spectra are "closest" to the unknown by some goodness of fit criterion. Extensive testing of the program has shown it to be highly reliable and extremely rapid for pure compound and binary mixture identification. In the 3 bit library search, the peaks heights of both the unknown mass spectrum and the library spectrum are encoded to 3 bits, or 8 levels. At each nominal pass, the peak height is an integer 1, where 0=1=7. The transitions between levels have been set logrithmetically as a function of the percent total ion current. The maximum mass range covered in the search is amu 12-243. By means of data input, narrower mass ranges can be searched. By relatively simple coding changes, it is also possible to mask out certain masses or mass number ranges in the search. Two versions of the program, using approximately the same amount of core is available: (a) Up to 30 unknowns per pass through the library can be handled. No detailed side-by-side spectral summary is provided. (b) Up to 20 unknowns per pass can be handled. A detailed side-by-side spectral summary is provided at the conclusion of the program. In both programs, core requirements are roughly proportional to the maximum number of unknowns to be handled on each pass through the tape.

LANGUAGE: FORTRAN IV (98%): ASSEMBLER (2%) MACHINE REQUIREMENTS: IBM-360/44 with 128K bytes of core PROGRAM SIZE: Approximately 7,821, including 6,832 data cards PRICE: Program \$280.00 Documentation \$10.00 PROCRAM NUMBER: NPO-11960

COMPUTERS

Includes programs and systems designed to manage, evaluate, and effect control of the operations of hardware resources; systems for the design, implementation, processing, and monitoring of software resources; general systems for the management of user data including information searches and retrieval and graphics support packages.

FLOW-CHARTER, A Program for Producing Flow Charts of FORTRAN Source Dacks, IBM-350 Version

The FLOW-CHARTER program is designed to produce flowcharts of programs written in FORTRAN G or FORTRAN H. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the programs under consideration. The program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: IBM-350
PROGRAM SIZE: Acproximately 600 source statements
PRICE: Program \$350.00 Documentation \$2.50
PROGRAM NUMBER: COS-02210

SLACMON-SLAC Software Monitor, Version 2.2

SLACMON, operating as a systems task or job, is designed to monitor hardware and software performance over a given period of time. A series of reports is produced that should aid in identifying areas of low utilization as well as performance bottlenecks. Monitoring is performed by counting various events (SVC calls 1/0 interrupts) and by sampling other (the changing of control blocks). Those familiar with statistical techniques will realize that as the number of these samples increase, the sampling results become more accurate (this is derived from the Law of Large Numbers). Thus, by using this sampling technique, it is possible to obtain a significant amount of performance data with very little additional systems overhead. SLAC-MON itself consists of three seperate modules whose structure and functions are often highly dependent upon various services provided by the OS Supervisor. Multitasking is used to obtain WAIT time and to perform the sampling mentioned above. This program, then, must be run under MVT or MFT with subtasking. Input to SLACMON IS twofold: the parameter field on the EXECUTIVE card, coupled with the corresponding operand in the operator's START command allows various functions to be performed or omitted: five data sets (optionally) provide names (of Q's, I/O devices, or modules) that SLACMON will look out for. Therefore, by careful control of these inputs, overhead can be reduced to a minimum; unwanted reports can be eliminated. Output from SLACMON consists of a series of reports (up to twelve) followed by a page summarizing both these reports and the run itself. Certain summary data may appear on the console device, if desired. The MVT software monitor is generally intended to identify bottlenecks and interactions rather than measure performance, although it certainly does the latter adequately. The output is most useful for tuning a system for peak performance and for indicating desirable hardware and software reconfiguration. SLACMON is written in Assembler Language (f. G. or H levels). It runs on IBM System/360 under OS/360 MVT or MFT with subtasking. No special requirements are imposed.

LANGUAGE: ASSEMBLER
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 7,013 source statements
PRICE: Pregram \$870.00 Documentation \$12.50
PROGRAM NUMBER: COS-02241

PROGLOOK - SLAC Program Performance Monitor

PROGLOOK consists of two programs, PROGTIME and PROGPLOT, which provide the user with a simple tool for making detailed measurements of his program while it is running. It can be used to measure any user program that can be run under OS/MVT, OS/MFT or VS2 rel 1.6, and with it the user can ascertain what action is necessary for him to take in order to improve the performance of the program. Performance improvement in frequently used programs benefits an entire computation facility by reducing run time and thus improving turnarcund time. PROGTIME uses the control clock to catch a picture of any program running under it and records this information in a data set. It is designed to handle overlay structures and dynamic programming linkages. The only constraint associated with this is that a task cannot attach more than

254 subtasks. The new version of PROGTIME uses an improved technique to eliminate interference from other jobs in the system. It will also properly time programs using the LOAD macro. These improvements increase the usefulness, and accuracy of the system considerably PROGPLOT accepts the specially formatted data sets and prints summaries of the observations. The two programs work in conjunction with each other to produce graphs that show where the program has spent its time (both run and wait time), and how performance can be improved.

LAMOUNGE ASSEMBLER (75%), FORTRAN IV (23%), UCL (2%)
MACHINE REQUIREMENTS IBM OS MVT, OS METVS2 rel 1 6
PROGRAM SIZE: Approximately 2,901 source statements
PRICE. Program \$640.00 Documentation \$7.00
PROGRAM NUMBER: COS-02251

BIGSYS - Bibliographic System

The Bibliographic System (BIBSYS) is a computer based system that was developed to enable users to establish and maintain a machine readable file of hibliographic information in standard MARC II processing format and produce a variety of hibbographic tools from the basic format. The BIBSV3 system is composed of four independent subsystems. These are file Maintenance, file Inversion, Report Production and Retriever. The File Maintenance updates the master bibliographic information file. The updating permits additions, deletions and changes to be performed both on whole records and on fields and subfields within individual records. The final phase of processing produces an accession number index which gives the status of each record on the master file and the date of the last transaction affecting it. The File Inversion program provides a generalized system that makes it possible to sort the master file records on a combination of various fields and subfields. This program also has an explode capability to provide a separate copy of the record for each time the tag is repeated, i.e., a record with three authors will appear three times in the final report once for each author. The Report Production program is a two program generalized package which produces a variety of printed output from the BIBSYS file The first program produces a print file on tape and the second program prepares and prints the report in the specified format. The Retnever program builds a sub-file of records selected from the master file on the basis of parameter cards read at the start of processing. The parameter cards constitute queries for records that meet certain qualifications. The openes are Boolean in natiae and may be batched for processing

LANGUAGE ANS COBOL
MACHINE REQUIREMENTS IBM 360
PROGRAM SIZE Approximately 12,000 Source Statements
PRICE Program \$1,300 (\$0) Documentation \$26 (\$0)
PROGRAM NUMBER: COS-02480

Fortran Analyzer

The Fortran Analyzer program is designed as an aid in the revision, machine conversion and documentation of existing Fortran programs. Source languages allowed as input for analysis are IBM Fortran G and H. CDC Fortraness and 63, GE 600 Series Fortran IV, IBM 7090 FORTRAN IV and HITAC (HITACHI) 5020 HARP Fortran for use in machine conversion, the user can also specify as an object! Fortran any one of the source Fortran languages

and any statements in the input program will be detected that are not allowed in the 'object' Fortran. Processing time is approximately one minute per 1000 Fortran source statements, and unless output is omitted, lines equivalent to four times the number of input cards are printed out. Printed output is controlled by the user and includes a program listing with flags showing the results of the analysis, a symbol table giving symbol attributes, symbol cross reference table, statement number cross reference table, a storage map showing the locations of symbols within COMMON areas, subprogram definition and cross reference tables containing subprogram names, argument forms, subprogram reference tocations, and undefined subprogram names. Additional user control options include output page titles, internal table size specification, input source Hollerith code control (BCD, EBCDIC or HITACHI), standard input and output logical unit number control, and printer page size control

LANGUAGE: Fortian IV (93%)
Assembler (-7%)
MACHINE REQUIREMENTS IBM 370
PROGRAM SIZE Approximately 10,887 source statements
PRICE Program \$970.00 Documentation \$10.50
PROGRAM NUMBER: COS-02510

EXTRAN - Expression Translator

This program is a language compiler for translating source instructions written in EXTRAN which is a symbolic language designed to emulate human communication methods in program construction by proceeding from general aspects to particulars. That is, a number of general statements are first written which describe the entire processing operation. Their form must conform to basic syntax reduirements, but each statement can be juit in a form similar to English sentences. In other words, the program design description itself is coded. Next, the meaning of the terms used in each general state nent is explained in another set of lines. Then the meaning of new words used in the explanation are explained in a new paragraph. An EXTRAN program is complete when the expressions introduced within it are all defined by means of forty basic supplied expressions or expressions previously defined in terms of these basic expressions and available in user libraries. Expressions introduced in the programming process may be in the form of phrases or sentences and are not limited to just one symbol or lexical term. An EXTRAN program is executed either by invoking the kenerator component to convert the set of basic expressions resulting from complete expression substitution into FORTRAN and then processing the FORTRAN source code or else an interpretive evaluation of the program may be carried out as an alternative option of the compiler component effecting expression substitution Because of the macro expansion capability, interpretive execution capability for all or part of a program, and the capability for editing a program into a library for common use, the EXTRAN compiler can be used not only as a general purpose computer language but also in the following wass. (1) Himmation of the requirement for flow charting in the design of programs because the design specifications can be written in EXTRAN (2) Construction of specific problem oriented languages without the need for individual compiler development by specifying expres sion forms and the contents of commands to be intro duced which are then entered into a user library (3) Pregaration of general purpose programs in EXTRAN from which special purpose FORTRAN programs can be

generated at compile time through user stipulation of parameters and expression substitution.

LANGUAGE: IBM FORTRAN (95%), IBM ASSEMBLER (5%) MACHINE REQUIREMENTS: IBM 360/370 PROGRAM SIZE: Approximately 10,400 source statements DISTRIBUTION MEDIA: 9 Track Unlabelled Magnetic Tape PRICE: Program \$1,180.00 Documentation \$17.00 PROGRAM NUMBER: COS-02520

NIPS - Fiztional Military Command Information Processing System, System 360 Formatted File System

The NIPS System 360 Formatted File System (NIPS 360) FFS) is a generalized information management and analysis system utilizing an English like control and query lang rage capable of accepting any machine readable data source—having—a definable—format. Structurally—and operationally the NIPS 360 FFS is most easily described in terms of the following major components which operate on the data files on the system (1) the File Structuring component (FS) which generates the communication arrays known as File Format Tables (FFT) describing the hierarchial relationships, relative location, and attributes of each data element within the records of a file and which are stored as part of the data file to be accessed by the other components when processing user language state ments (2) the File Maintenance Component (FM) which generates and, or revises the user's data files. Several user languages are provided which permit the analyst to specify data validation procedures, logical data examination and manipulation, and summarization. The normal output of this component is the data file in updated form, however, auxiliary output files can be requested. (3) the Retrieval and Sort Processor (RASP) is used to extract information from one or more data files based on search criteria specified in the form of retrieval statements or queries and to sequence this extracted information in a variety of ways as determined by the requirements of the final report to be produced Replacement of query operands and sort variables for prestored queries is permitted at execution time. Relational (conditional) operators may include user defined functions or subroutines. (4) the Output Processor Component (OP) which is used for formal report production based on user formatting specifications. A data file itself or an output data file from the RASP component may serve as input to the Output Processor. Output from the OP may be directed to a printer, card punch, or magnetic tape, and may include editing, data conversion and arithmetic computations (5) the Terminal Processing Component (TP) which utilizes local IBM 2250 devices and remote 2260, 2741, or 1050 terminals as input output units allows the terminal user to interrogate data bases with queries that are edited on line before being processed against a data file through the Quick Inquiry Processor (QUIP) Other functions available through QUIP are similar to those performed by RASP and OP including report formatting. Output data may be reviewed in a conversational mode at a terminal or directed to a printer. The Source Data Automation (SODA) processor of the TP component provides the capability of remote data file maintenance with input data edited, corrected, and processed using prestored FM logic statements. The structure of data records which the NIPS 300 FFS supports is hierarchial where a collection of record data elements at the same level is termed aiset. At the first level in the data record hierarchy is a fixed set, of which there may be one per record, consisting of data elements requiring only one value to meet recording requirements. Subordinate to the fixed set may be periodic sets of dynamic data consisting

of generations or subsets of data elements that are logically related and where all subsets of a given periodic set are identically formatted. For each fixed set the user may define up to 255 independent periodic sets each of which may have from 1 to 100 defined fields with the number of subsets for a given periodic set also user specified. In addition to the fixed and periodic sets a record may contain, variable length sets containing unformatted data (usually of textual variety) definable at the periodic level. One variable set may be associated with the fixed set and one with each periodic subset. The data element value modes available to the user are numeric, alphanumeric (the full EBCDIC character set) and the geographic coordinate mode which allows storage of latitude and longitude coordinates for retrieval using the geographic retrieval operators. Under the NIPS 360 FFS the user has file capability of defining routines which may be used to perform data value conversion for transaction data elements as well as for data elements residing in stored records. In addition numeric mode elements may be edited during output processing to suppress leading zeroes, insert decimal points, and perform other editing functions. Although each component of the NIPS 360 FFS has its own language they are basically similar and differ only in their application to a problem. Each language is free format and consists of two basic types of words: (1) System reserved words analogous to verbs or conjunctions in English sentences which are recognized as indicating specific operations and which in combination define the logic to be used by the system component (2) User supplied words analogous to the subject and or objects of an English sentence that indicate typically the specific qualification for action or in general identify what is involved in a processing function and the result obtained. The NIPS 360 FTS has been designed and programmed for an IBM System, 360 Model 50H (256K core size). It will also operate on a Model 40H and larger models of the System, 360. Without on line terminals, it will operate on a Model 40G or 50G (128k core size). A minimum configuration can include three IBM 2311 Disk Units or a single IBM 2314 Disk storage unit, a card reader. and an online printer. Tape drive requirements are determined by the user's requirements and range from none to a quantity sufficient to perform the largest sort the user may require. When available disk sorting is used to the capacity of the direct access devices. NIPS 360 FFS will operate under PCP, MFT, MVT, VS1, or VS2 operating system configurations and is not restricted to any one level of the operating and uses subsequent releases as they become available

LANGUAGE: ASSEMBLER (Executable code also supplied) MACHINE REQUIREMENTS: IBM System 360 Series PRICE Program \$2,470.00 Documentation \$100.00 PROGRAM NUMBER: DOD-00017

General Purpose Overlay Loader for CDC 6000 Series Computers

This program package is a modification and improvement of the NASA Structural Analysis (NASTRAN) Linkage Editor for CDC 6000 Series computers which is designed to utilize central memory storage efficiently for medium to large programs. It allows the user to arrange a program into an overlay structure consisting of links and segments within links which can be assigned the same origin addresses and loaded at different times. Advantages of this linkage editor and associated segment loader over others available are an unlimited number of overlay levels; the description of overlay segments to the linkage editor.

through directives specifying subprograms to be included and the libraries they reside on this allowing the program to be structured after it has been coded; the implicit loading of segments facilitated by their storage on a random access file; the dynamic allocation of memory as each segment is loaded; the explicit positioning of named commonblocks; the acceptance of either FTN or RUN Fortran object code by the linkage editor, the maintenance of communication between all levels of overlay; the capability of updating individual links without relinking the entire program; and the ability to selectively rename external references. This linkage editor executes under the SCOPE Operating System (Versions 3.3 or earlier) as a user program with the linkage editor object code loaded using the CDC loader. This vendor loader is also used to load the zero level link generated by the linkage editor. The zero level link remains in central memory at all times; thereafter all link and segment load requests are serviced automatically by a segment loader contained in this link utilizing tables generated by the linkage editor for all segments required. Minimal memory requirements for execution of this linkage editor are 64K octal words. This field length will typically accomodate a program contain ing up to 200 subprograms

LANGUAGE: FORTRAN IV (43%) COMPASS (57%)

MACHINE REQUIREMENTS: CDC 6000 Series PROGRAM SIZE: Approximately 9,624 source statements PRICE: Program \$1,250.00 Documentation \$13.50

PROGRAM NUMBER: DOD-00038

S/360 AUTOFLOW Preprocessor System

Since programs written for non IBM computers cannot be directly processed by the S-360 AUTOFLOW System (a flow charting procedure), four preprocessors have been developed to convert Assembly Language and FORTRAN programs into a format acceptable to \$ 360 AUTOFLOW AUTOFLOW functions on the printer or the SC-4020 plotter. The four preprocessors are written in S 360 Assembly Language and they each occupy approximately 250K bytes of core. The AUTOFLOW System, with preprocessors, is comprised of three load modules. The first module, the Master Control routine, is held in memory and is called in via the EXEC card. The second module, one of the four preprocessor versions, is called in by Master Control and processes the input data producing two temporary data sets on disk. The third routine, the AUTOTOW load module, is called by Master Control to process. The data sets on disk. Each preprocessor requires the Master Control routine, a FORTRAN processor, General subroutines Part A and B, and Input: Output and System Macros: System Macros are used to easi, the assembly fanguage burden, making use of the macro capability feature of the 360 Assembler. Four preprocessor versions are currently available accepting as input programs written in Assembler or Fortran Version 1 (GSC 11330) is for use with programs written for SDS 900 Series machines, Version 2 (GSC 11331) for DDP 24,174, or 274 machines, Version 3 (GSC 11332) for CDC 30001 Series machines, and Version 4 (GSC 11333) for Univac 1100 Senes machines

LANGUAGE: Assembler
MACHINE REQUIREMENTS IBM 360-370
PROGRAM SIZE Approximately 7600 source statements
PRICE Program \$580.00 Documentation \$14.00
PROGRAM NUMBERS: GSC-11330, 11331, 11332, 11333

FORTAP-FORTRAN Tapo Conversion Packago

This system is a package of subroutines written to permit the UNIVAC 1107/1108 to read or write unformatted FORTRAN tapes compatible with other binary computers: The FORTRAN tape conversion package - FORTAP consists of two externally identified subroutines - CREAD and CWRITE - and six other subroutines. These subroutines convert single precision integers and real numbers with single or double precision into a compatible form. The FORTAP subroutines are dependent upon The UNIVAC FORTRAN Compiler and the FORTAP Computer Characteristics Table. Any change to the compiler that effects the number and type of machine instructions may require rewriting the FORTAP backage. CREAD and CWRITE after the machine code generated by the FORTRAN read or write statements. The other routines are serially reusable and can be used in loops with a parameter that can be established by the computer identifier. The parameter for CREAD and CWRITE and its values is limited to those computer identifiers which are contained in the computer characteristics table. The FORTAP Computer Characteristics Table lists an associated program symbol for each of 19 items and gives a verbal description of each item. The associated program symbols are not associated with any particular values until the proper computer is found in the table. When the computer if found, then, the particular values for that computer are stored in the respective symbolic addresses. At present, the following computers are included in the table CDC 3200, 3600, 3800, 6600, IBM 360, 7030, 7040, 7090, and 7094.

LANGUAGE: SLEUTH
MACHINE REQUIREMENTS: UNIVAC \$108, EXEC II
PROGRAM SIZE: Approximately 3,601 source statements
PRICE: Program \$610.00 Documentation \$6.50
PROGRAM NUMBER: GSC-11398

Source Deck Complession and Update Program

A computer program, CAPS, has licen developed to produce and update compressed symbolic decks from Hollerith source decks, and provides to their reconversion to Hollerith form. This procedure allows compact storage of programs on cards, tape or disk. The size of a compressed deck, in most cases, is less than one fourth that of the Hollerith deck. The CAPS program may be used to process any source language provided that the language uses only column 1 through 72 and doc anot contain any of the CAPS card statements. A CAPS library is a compressed symbolic library of CAPS decks on a sequential data set The library can be selectively updated by a single CAPS run and the Hollerith output may be used for subsequent assembly or compilation. The complete program is written in FORTRAN and ASSEMBLER language for the 360 using OS 360 It requires 100000 (DEC) BYTES of memory including system library routines. The user is to supply system subroutine LAND (logical and function). Linkage will give an unresolved external reference error if this function is not used

LANGUAGE FORTRAN IV (95°.), ASSEMBLER (5°.) MACHINE REQUIREMENTS IBM 360 PROGRAM SIZE Approximately 1,073 source statements PRICE Program \$310.00 Documentation \$4.00 PROGRAM NUMBER: GSC-11545

SGINDEX-OS/360 - System Generation Cross Reference Index

This program provides an easy-to use but comprehensive cross reference index of the sysgen results which can be used for modifying the Operating System (OS), applying PTF's, or writing subsystems which interface with OS. The program collects key data from the Stage II input for an OS./360 sysgen upon generation of a new operating system, sorts it, and prints a formatted listing of the index entries collected. A number of parameters are available for controlling the content and format of the output listings. SGINDEX is written in Pt./1 and uses a region of about 200K in an MVT environment, although this may be decreased by compiling with OPT=0. It requires SYSI PtIL-IB for Imkage editing and SYSI SORTLIB for the OS sort package at run time.

LANGUAGE: PLZI
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE Approximately 1,511 source statements
PRICE: Program \$200.00 Documentation \$5.50
PROGRAM NUMBER: GSC-11612

CSS - Character String Scanner

A computer program called Character String Scanner (CSS), is presented. It is designed to search a data set for any specified group of characters, and then to flag this group. The output of the CSS program is a listing of the data set. being searched with the specified group of characters being flagged by asterisks. Therefore, one may readily identify specific keywords, groups of keywords or specified lines of code internal to a computer program, in a program output, or in any other specific data set. Possible applications of this program include the automatic scan of an output data set for pertinent keyword data, the editing of a program to change the appearance of a certain word or group of words, and the conversion of a set of code to a different set of code.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS IBM/360
PROGRAM SIZE Approximately 79 source statements
PRICE: \$95.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: GSC-11787.

STRCMACS - OS/360 Assembly Language Structured Programming Macros

STRCMACS is a set of twenty four macros that enable structured programming techniques to be incorporated into IBM OS 360. Assembler language programs by providing the basic control structures which replace the use of branch instructions and by providing ands for doing stepwise, relinement, programming. Control structures provided include a method for grouping statements into blocks through block initiating and block terminating macros, a decision structure implementing the if then else construct, and an iteration structure, which may be conditional, through the DO and WHILE macros. Additional convenience macros provided to simplify conceptualization and coding include the DOCASE and EMI macros. To aid stepwise retinement, STRCMACS provides for module definition through the procedure delineating macros PROC and CORP with the resultant procedure invoked by using the IBM CALL macro. Debugging options whose invocation

is under user control designed into the structured macros include the option to print on the assembler source listing as comments the name, sequential number, and static nesting depth of each block; the ability to force all procincines to be generated as in line character constant to facilitate location of the corresponding code is dumps, the option to maintain execution count statistics on specified procedures and blocks; and a procedure trace option which maintains a record of the last 257 procs executed

LANGUAGE: ASSEMBLER
MACHINE REQUIREMENTS: IBM 360/OS
PROGRAM SIZE: Approximately 3,041 source statements
DISTRIBUTION MEDIA 9 Track, 800 BPI, no label tape
PRICE: Program \$790.00 Documentation \$24.50
PROGRAM NUMBER: GSC-11938

Library Documentation System

Bibliographic Products Subsystem is a system of programs designed to create and maintain a bibliographic data base. The system was designed to process MARC II Processing Format Structure' records, used by the Library of Congress, described in Books: A MARC Format', Library of Congress, Washington, 1972. MARC II compatible records are added, changed, or deleted in a bibliographic file at the word, subfield, tagged field, or record level Generated sort keys are appended for arranging the output in product, collection, and filing sequence. Catalogs may be dictionary, divided or combination. Entries are arranged in alphabetical sequence according to rules established by the Library of Congress. Title, subject, and for content keyword indexes are filed by key word then title and, or call number.

LANGUAGE, COBOL (96%), ASSEMBLER (4%)
MACHINE REQUIREMENTS, IBM 360-370
PROGRAM SIZE Approximately 11,113 source statements
PRICE, Program \$1,230.00 — Pocumentation \$20.50
PROGRAM NUMBER: GSC-11952

BCMRET - Bellcomm Information Retrieval System

BCMEET, the Bellcomm Information Retrieval System. has been developed over the past two years to satisfy Bellcomm's need for a generalized information storage and retrieval system. The file generation and file maintenance programs which have been written for BCMRET are general purpose routines. These programs make it possible to use the system not only in the usual applications involving administrative data and document information, but also in applications involving purely numerical, engineering data. BCMRET is capable not only of generating and maintaining a file, but also of gathering statistics, sorting output, and generating final reports for output. In order to use any retrieval system on an aggregate of information elements, the aggregate must first be given some structure which will make possible the computer recognition of each element. Such a structured aggregate is called a file. There exist two general types of file: a fixed file, in which the exact location of each information element is predetermined, and a variable file, in which the location of an information element depends on the size of every element and on the total number of elements. BCMRET makes use of a variable file and admits an arbitrary number of information elements of arbitrary size. This flexibility gives the user great ease in changing, adding to deleting information anywhere in a file

LANGUAGE: FORTRAN V (94.7%); ASSEMBLER (5.3%)
MACHINE REQUIREMENTS: UNIVAC 1108
PROGRAM SIZE: Approximately 15.229 source statements
PRICE: Program \$1.120 00 Documentation \$18.00
PROGRAM NUMBER: HQN-10426

PLTCON - Contour Flotting Program

PLTCON, Contour Plotting Program, provides a general contour plotting capability using interpolation to reduce the number of function values required. In many studies the function f is now known as a simple equation but rather. the determination of its value for a particular x and y involves costly computations or measurements. It is, therefore, desirable to be able to generate and plot the various contours of flusing as few function values as possible. Let f(x, y) be a continuous function whose value is known at a subset of a discrete set of equally spaced points of the x-y plane. PLTCON reads a number of such function from any number of files and oversees the generation and plotting of f, x, or y constant contours of these functions. SC-4020 and/or printer plots are generated with up to ten sets of contours per frame for the SC-4020 plots. The printer plots contain one set of contours per page. Two directional parabolic interpolation is used to provide sufficient point density without increasing the function evaluations required.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC-1108, SC-4020 Plotter
PROGRAM SIZE: Approximately 3,600 source statements

PRICE: Program \$350.00 Documentation \$3.50 PROGRAM NUMBER: HON-10651

RECON/STIMS - Remote Console and Scientific and Technical Information Modular System

The current NASA/STIMS (Scientific and Technical Information Modular System) system consists of five unique subsystems. These are the Online Input and Photocomposition subsystem, the File Maintenance Subsystem, the batch processing Search and Retrieval Subsystem, the Publications Subsystem, and an online search and retrieval system called RECON. The NASA Online Input and Photocomposition System includes all the activities necessary in document data reduction, online and batch data entry, and online data correction for the STIMS Data Base. The File Maintenance Subsystem can be used independently of the other subsystems to build and maintain a data base. The File Maintenance Subsystem accepts transactions, converts them to internal system codes, and updates the data base. The data base architecture is built on a generalized record structure. The data characteristics, which make one file different from others, are placed in data definition, parameter tables. These parameters function to identify fields, establish maximum field lengths, determine whether a field is to be fixed or variable length, determine whether fields can have subfields, and specify the characteristics of the data. The Search and Retrieval Subsystem uses Boolean logic equations to search the data base for the information requested by the user. In preparing a publication, the Search and Retrieval Subsystem extracts the data for the publication. The Publications Subsystem then formats the publication according to the parameters in a publication format table. The output from the Publications Subsystem can be either printer output or magnetic tape. The RECON system is an online search and retrieval subsystem that accesses the data base prepared by the File Maintenance Subsystem. RECON is available separately from STIMS as program number HQN-10694.

LANGUAGE: PL1 and ASSEMBLER
MACHINE REQUIREMENTS: IBM 360
DISTRIBUTION MEDIA: Four 9 Track, Standard level IBM
IEHMOVE 'Unloaded PDS' Magnetic Tape
PRICE: Program \$2,530.00 Documentation Hardcopy
\$274.00 Microfiche \$40.00
PROGRAM NUMBER: HQN-10699

FFCP1 - Fortran Flow Chart Program

The purpose of this program is to provide the capability of producing computer program flow charts suitable for inclusion in final program documentation utilizing FOR-TRAN IV type of coding. Thus the program precludes the requirement for manual preparation of flow charts and provides a presentation using standard flow chart symbols. The input to the program is comprised of one or more FORTRAN card decks, from which all control cards and blank cards are removed. If these cards were not removed the program would just compile. Each deck normally starts with a comment card, but may start with a FORTRAN statement. Each deck must end with an End card. The output from the program consists of a magnetic tape which, when processed by the SC-4020 plotter, produces final computer program flow charts and a cross-reference listing between program statement numbers and flow chart page numbers. Options of microfilm only or both hardcopy and microfilm are available.

LANGUAGE: FORTRAN IV (5%) GMAP (95%)
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 396 source statements
PRICE. Program \$190.00 Documentation \$7.00
PROGRAM NUMBER: KSC-10450

ADMIS - Automated Data Management Information System

The Automated Data Management Information System (ADMIS) is a computerized information and retrieval system used to control manned space flight management and administration documents. The sophisticated input, verification and standardization is controlled by the Mainline subsystem which is a composite of six programs. The mainline subsystem contains 3 master files, a Document and Distribution Master File, a Code File Master. and a Common Data File Master. The ADMIS Document and Distribution Master File contains all data oriented toward a specific document; it is the primary source of reports generated by the ADMIS system. Each Document is represented on the Document and Distribution Master File by a group of records all containing a unique Document Serial Number. This group of records is composed of one document record, one distribution record for each recipient of the document, and one summary record. The ADMIS Code File provides system discipline by insuring that standard codes and standard nomenclature is used throughout the system. The input data is compared with the ADMIS Code File standards, and any deviation causes a rejection and the creation of appropriate error messages. Data that is accepted by Code File standards allows related data sets to be generated and entered into the Document and Distribution Master File. The Common Data File contains data for each Requirement Document on the Document and Distribution File. It is used to generate transactions to update documents which respond to a related requirement. These generated records represent data which is common to both the requirement and the response document. The mainline subsystem contains a program to list all records on a Master file and a program that will give a statistical analysis of duta traffic for the past 6 months and predict data traffic for the next 12 months. The Keyword subsystem consists of three programs and one masterfile. This system will produce a cross-reference listing and also retrieve documents on a keyword basis. The remainder of information such as, distribution lists, mailing labels, data by package type, title lists, document indexes, etc.

LANGUAGE: COBOL (80%); GMAP (20%) MACHINE REQUIREMENTS, GE 635 PROGRAM SIZE: Approximately 25,000 source statements PRICE: Program \$2,410.00 Documentation \$176.00 PROGRAM NUMBER: KSC-16619

Multiple Utility Computer Program

This is a system of two computer utility programs that permits an individual with very little data processing training to establish a field by field update of a master-file and then select different sorts and reports without establishing a new program each time. The user can input data on an (EAM) card and receive up to ten sorts of specific data fields designated by the user. The user also has the capability of controlling report headings and card column positions. The multiple utility computer program permits various sorting of information and displaying this information in many different ways. It was necessary to use an 80.80 input keypunch card and to allow the user to have complete control of data input, field length, headings and sorts. Previously, manual methods were used or a special program for each system was required. The programming delays and inconveniences for obtaining simple sorts with headers, page numbering, etc., were excessive. Some of the advantages are an extremely fast and efficient way to sort data so that the user has almost complete control, rapid turnaround time, and the elimination of development costs for programming changes each time a new requirement occurs. The program operates using less than 10 minutes (CPU) task and wait time. It was originally designed and written for an IBM-360/65 OS MVT using 2314 discs and 9 track tape drives, but can be modified to operate on available hardware.

LANGUAGE: ANSI COBOL, Level 77
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 598 source statements
PRICE: Program \$470.00
PROGRAM NUMBER: KSC-10778

RFI - Remote File Inquiry System

The Remote File Inquiry (RFI) system is designed for maintaining and interrogating user definable data files from remote terminals using an English like free form query language easily learned by persons not proficient in computer programming. The RFI system operates in an asynchronous mode allowing any number of inquiries within the limitation of available core to be active concurrently. The file structures supported by RFI include variable length text records as well as repeated fields. For on line information retrieval using RFI an inquiry sentence is composed of five functional parts: (1) the function name or file identification, (2) an optional title phrase used to provide report titles, (3) the verb phrase, (4) the object or qualifier phrase, and (5) an optional sort phrase giving the capability of sorting the selected data in ascending or

descending order. For upta retrieval two verbs are available: LIST which prints out the contents of a specified field in all records which meet the selection criteria and TALLY which totals a specified numeric field or simply counts the number of qualified records if no field is specified. For on-line updating of records within a file, three additional verbs are available. FDD will add a complete record, including specific values for all fields listed. DEL (delete) will remove any record or sub-record meeting the criteria listed CHG (change) will change the contents of the fields listed to the values included in the command statement. The qualifier phrase for record may be examined for equal, not equal, greater than, less than, and combination conditions (e.g., not less than.) Both AND and OR connectives are available for compounding conditions. RFI provides security control for all files loaded on the system. A five position code, which can be changed easily by the operator, is used to control access to each file. Separate codes can be provided for reading and updating, if required. The RFI system is designed for the IBM 360 (Model 40 or above) operating under OS/MFT and assumes the availability of at least two IBM 2314 (or equivalent) disk drives and one IBM 2401 tape drive. Minimum core storage required totals 120K for two 0/S MFT partitions; approximately 40K for the Message Control Program and a minimum of 60K for the Inquiry Partition. This is expanded automatically if more core is made available to allow for simultaneous operation of more requests. The system is designed to service up to 99 Teletype or Teletype compatible terminals in its present form; however, by redesign of the Message Control Program any type of terminal using a page format may be accomodated

LANGUAGE: IBM ASSEMBLER (Level F)
MACHINE REQUIREMENTS: IBM 360/37J 0S/MFT
PROGRAM SIZE: Approximately 20,000 source statements
PRICE: Program \$1,590 00 Documentation \$37 00
PROGRAM NUMBER: KSC-10837

Generalized Digital Contouring Program

This is a digital computer contouring program developed by combining desirable characteristics from several existing contouring programs. It can easily be adapted to many different research requirements. The overlaid structure of the program permits desired modifications to be made with ease. The contouring program performs both the task of generating a depth matrix from either randomly or regularly spaced surface heights and the task of contouring the data. Each element of the depth matrix is computed as a weighted mean of heights predicted at an element by planes tangent to the surface at neighboring control points. Each contour line is determined by its intercepts with the sides of geometrical figures formed by connecting the various elements of the depth matrix with straight lines. Although contour charts are usually thought of as being two dimensional pictorial representations of topographic formations of land masses, they can also be useful in nortraying data which are obtained during the course of research in various scientific disciplines and which would ordinarily be tabulated. Any set of data which can be referenced to a two dimensional coordinate system can be graphically represented by this program.

LANGUAGE: FORTRAN IV (13.3%), COMPASS (86.7%) MACHINE REQUIREMENTS: CDC 6000 SERIES PROGRAM SIZE, Approximately 17,446 source statements PRICE: Program \$1,360.00 Documentation \$7.50 PROGRAM NUMBER: LAR-10372

CODER - Common Generation Program

CODER is a computer program designed to provide common storage to FCRTRAN non-executable associated statements. The program automatically generates the type, common, dimension and equivalence statements for FORTRAN programs. Manual methods of designing and updating common storage are tedious and errors as sociated with common storage are often elusive. Some of the advantages of using CODER are: (1) It automatically computes the length of common by summing the array lengths in the data base; (2) Efficient use of core storage can be kept at a minimum by eliminating unused or imbedded common storage; (3) Common blocks may be completely redesigned by rearranging the data base input deck during program development or for production updates: (4) Arrays may be reduced to the lowest definable size; (5) Only common variables used in a subroutine need to appear in that subroutine; (6) A storage locator will be referenced by the same symbol wherever it is utilized; (7) Each variable in common is defined which is a very important component of program documentation; (8) Programming updates which involve the common block are simplified and automatic. CODER may be easily converted to other computer systems which have FOR-TRAN compilers.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 674 source statements
PRICE: Program \$230.00 Documentation \$2.50
PROGRAM NUMBER: LAR-10959

DOC - Automatic Documentation Computer Program

DOC is a computer program that automatically generates internal documentation of each program, function, or subroutine as a unit. The following items are output for each element: (1) List of arguments (2) List of subroutines required (3) List of local symbols (4) List of common variables that are computed and used (5) List of common variables that are computed only (6) List of common variables that are used. The purpose of DOC is to facilitate documentation of computer programs, especially large scale programs. All variables used in a program unit are identified and placed in one of several lists. Internal documentation of each program element is provided via comment cards that may be placed within the source deck. Automatic documentation is meticulously accurate and complete. EOC provides documentation of an average subroutine (400 lines) in 4.0 seconds of CDC 6500 computer time and utilizes only 60,000 words of storage. Manual methods of providing the same information are time consuming, costly, and inaccurate.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,964 source statements
PRICE: Program \$590.00 Documentation \$5.00
PROGRAM NUMBER: LAR-10980

ALTLIB - Automatic Computer Subprogram Selection from Application Program Libraries

Modular programming techniques are currently in widespread use in the development of scientific and engineering computer programs at the NASA Langley Research Center. These techniques involve the development of frequently used algorithms into modular (subprogram) form and the collection of application modules supporting a particular area into an application-oriented

library. This library can then be employed repeatedly by programmers working in the same area of application to simplify new program development. A major problem; however, it r people maintaining their own applicationoriented nurary is the complexity and volume of controlcard programming that must be performed to achieve subprogram selection. The Alternate Library Access (ALTLIB) program provides a solution to this problem. ALTLIB is a general-purpose digital computer program that automates the subprogram selection process. ALTLIB analyzes the user's program to determine all external requirements ALTLIB then proceed a select from the alternate library file all subprograms that a user's program requires. The selected subprograms and the user's object file are then merged onto a file designated by the user for subsequent loading and execution.

LANGUAGE: FORTRAN IV (53%): COMPASS (47%)
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 956 source statements
PRICE: Program \$370.00 Documentation \$5.50
PROGRAM NUMBER: LAR-11124

ODINEX - Executive Computer Program for Linking Independent Computer Programs

ODINEX is a computer program for linking independent computer programs into an interdependent system of programs by controlling the sequence of execution of a network of program elements and maintaining a data base of common information which forms the communication link among the programs. Any program element may access or modify the data base through the ODINEX executive. The ODINEX program is structured to provide the following: (1) A dynamically constructed data base containing all interprogram data. These data can be saved at user selected points in the simulation. (2) A language for controlling the execution of an arbitrary network of independent programs by simple commands. The flow path may be based on information from the data base. (3) A control card data base for storing information with regard to the intrieval and execution of individual programs. These data base files call be undated either by a separate run or dynamically in the simulation. (4) A language for automatically retrieving data base information as input to any program in the network using an information access and retrieval system included as an integral part of the ODINEX executive. The language requires no modificatio: to the independent program. (5) A simple technique for allowing any program in the network to update the data base. The technique does not influence the normal standalong operation of the program. (6) A capability for generating one or more reports describing the status of the design. This information can be printed as a part of the normal computer output. (7) Operational flexibility to allow batch or interactive modes of operation. ODINEX has general applicability throughout industry wherever multiple program tasks are involved. Any process involving more than one program for which the independent program elements are available can be synthesized.

LANGUAGE: FORTRAN IV (93%), COMPASS (7%)
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 4,571 source statements
PRICE: Program \$650 00 Documentation \$17.50
PROGRAM NUMBER: LAR-11324

BLKIO - An I/O Buffering Scheme with Skipping Capability

The subroutine BLKIO provides an efficient structure to accomplish input/output commands. It does this by

blocking data. Blocking is a process of accumulating (or removing) logical records in a buffer. For reading, one large buffered (also called blocked) record is read. Then, as a read request is made, one logical record is removed from this buffer. For writing data, data is accumulated in a buffer until it is filled. A write request for this buffer is made, and the process resumes filling. BLKIO reduces the number of calls to disk or tape; therefore, reduces Operating System calls. It provides an alternative to FORTRAN 1/O requests. BLKIO provides a complete file manipulation that allows forward and back spacing of record and forward and back spacing of files in addition to its read/write capability. The read/write capabilities also provide certain flexibilities not available in the FORTRAN read/write. BLKIO requires the user to follow precise calling sequences. For instance, the last write must be followed by an end-of-file request by means of an end-offile BLKWRIT call to flush all data from the buffer. The logical record size is important. If the logical record size is between I and N, when N=the buffer size, BLKIO does provide a speed advantage. If N is greater than the buffer size, BLKIO should not be used. The time advantage for I/O can be closely approximated by the buffer size used. This advantage is approximately equal to the buffer size/(1‡n), where n is the average record size used.

LANGUAGE: COMPASS
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 903 source statements
PRICE: Program \$50.00 Documentation \$2.50
PROGRAM NUMBER: LAR-11414

Program: for Interfacing a H-P Model 9830 Calculator with a H-P Model B Multichannel Analyzer

This program is a software package designed to allow interfacing a Hewlett-Packard Model 9830 calculator with a Hewlett-Packard Model 5401B multichannel analyzer.

LANGUAGE: BASIC
MACHINE REQUIREMENTS: H-P 9830 and H-P 5401B
PROGRAM SIZE: Not Applicable
PRICE: \$35.00
NOTE: The price includes the documentation and a
program listing only. The documentation is rit sold

separately from the program listing.

PROGRAM NUMBER: LAR-11698

FORTRAN IV - Subroutines for Generating Printed Plots

This set of four subroutines provides printed plots as part of normal cutput. The subroutine PLOTXY is called for plotting a single curve, while PLOTMY is called for plotting multiple curves. When using PLOTXY, the values to be plotted in the x-direction must be in sequence; if they are not, prior to calling PLOTXY, subroutine SORTXY must be called to make the necessary rearrangements. For either PLOTXY or PLOTMY, if the range of a variable to be plotted is unknown, the subroutine SKALE must be called prior to calling PLOTXY or PLOTMY. These subroutines have been generalized so that, if desired, the programmer may choose to use one or more of several options that permit him to control such things as the appearance of the grid, the scale for either variable, and plotting character. The programs are almost entirely machine independent and the documentation is written to simplify the changes required to adapt the plotting system to other machine configurations.

LANGUAGE: FORTRAN G or H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 582 source statements
PRICE: Program \$280 00 Documentation \$9.50
PROGRAM NUMBER: LEW-10857

PLOT3D—A package of FORTRAN Subprograms to Draw Three Dimensional Surfaces

Plot3D is a package of programs to draw threedimensional surfaces of the form z = f(x,y). The function f and the boundary values for x and y are the input to PLOT3D. The surface thus defined may be drawn after arbitrary rotations. However, it is designed to draw only functions in rectangular apprehinates expressed explicitly in the above form. It can't, for example, draw a sphere. Output is by off-line incremental plotter or on-line microfilm recorder. This package, unlike other packages, will plot any function of the form z = f(x,y) and portrays continuous and bounded functions of two independent variables. With curve fitting; however, it can draw experimental data and pictures which can't be expressed in the above form. The method used is division into a uniform rectangular grid of the given x and y ranges. The values of the supplied function at the grid points (x,y) are calculated and stored; this defines the surface. The surface is portrayed by connecting successive (x,y) points with straight-line segments for each x value on the grid and, in turn, connecting successive (x,y) points for each fixed y value on the grid. These lines are then projected by parallel projection onto the fixed yz plane for plotting.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360 and on-line CDC
microfilm recorder
PROGRAM SIZE: Approximately 355 source statements
PRICE: Program \$160.00 Documentation \$5.00
PROGRAM NUMBER: LEW-10482

Algorithm for Reducing the Number of Required Points in a Graphical Data Set

The oversperification of graphs by a large number of points often makes the time required the graphs excessive. A subroutine called RDCPT3 has been developed for reducing the number of points required to produce the graph. RDCPTS will produce an accurate and exact graphical display with a much reduced data set. Where plots of lower precision are acceptable, the algorithm can be even more effective in reducing the time and cost required in graphical production. The technique used in RDCPTS involves testing for deviation from line segments. The subroutine finds a subset of the original set of points such that all of the original points are within a certain tolerance of the line segments defined by the subset. The algorithm used in RDCPTS is fast, but does not necessarily reduce the number of points to the minimum number that satisfy the tolerance. As currently written, RDCPTS cannot reduce the number of points by a factor greater than 32. The first and last points are always included. This subroutine is narticularly valuable for use with Benson-Lehner plots since it can make the plotting much less expensive. In addition, the resulting plots are much sharper and easier to read.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM:360
PPOGRAM SIZE: Approximately 123 source statements
PRICE: Program \$260:00 Documentation \$2.50
PROGRAM NUMBER: MFS-15107

OSA% -- Variable Length Input/Output Routine

This is an OS/360 assembly language routine with FOFTRAN (0S/360) calling sequences using QSAM data ma lagement routines to read/write sequential data sets. Only one data set each can be input and output at a time. To input/output more than one data set, the old data set must be closed prior to input/output of the new set. Data sets are automatically open when GETR or PUTR is called and the DCB for GETR or PUTR is closed. Data sets are closed via calling ENDQ. Two options are provided for closing data sets: close and position at beginning of the data set and close and position at the end of the data set. This routine is very useful in that it provides the ability to read records of unknown length on OS/360. Program documentation consists of a program source deck and a program listing with extensive documentation on the usage and description of the routine within the comments of the listing.

LANGUAGE: ASSEMBLER MACHINE REQUIREMENTS: IBM-360 PROGRAM SIZE: Approximately 300 source statements PRICE: \$25.00 NOTE: The price includes the documentation and a program listing. The documentation is not sold seperately from the program listing. PROGRAM NUMBER: MFS-18725

MIRADS—Marshell Information Retrieval and Display System

The Marshall Information Retrieval and Display System (MIRADS) is an on-line data storage and retrieval system which allows the user to extract and process information from stored Data Bases. The use of remote terminals to extract and display data from the Data Bases provides a fast and responsive method of obtaining needed information. This on-line processing eliminates the extensive data processing cycle normally required when using an off-line or batch processing mode. The system consists of a general purpose computer program containing several functional subsystems that provide the overall capabilities of the total system. IIRADS is a command driven system with on-line editing of user commands which provides error diagnostic messages and recovery procedures that assist in the utilization of the system. The system can process any number of data files via a file Dictionary (one for each file) which describes the structure of the file to the system. New files may be added to the system at any time by creating a file Dictionary for the new file, MIRADS provides a highly diversified choice of data processing functions to satisfy user requirements. MIRADS consists of several programs, each performing a series of distinct functions. These programs are grouped together to form two subsystems, Search and Retrieval Subsystem (S & R) and Direct Access Data Display Subsystem (DADDS). Each program is further subdivided into modules to perform various subfunctions. The Search and Retrieval Subsystem provides the user the capability to select and process process variable data without extensive searches. In response to a user query, the system provides the capability of searching specified data files, sorting the files into a specified order, performing simple or complex computations, printing or displaying the results, and updating the Data Base. The Direct Access Data Display Subsystem provides the capability to access data files, process data, and present results as specified by user commands and specified output formats.

LANGUAGE: FORTRAN V (10.8%) Assembler (22.5%) COBOL (66.7%)
MACHINE REQUIREMENTS: UNIVAC 1108 DCT-500 or Uniscope 300
PROGRAM SiZE: Approximately 23,500 source statements PRICE: Program \$2,470.00
Documentation \$38.00
PROGRAM RUMBER: MFS-22536

Computer Utilization Prediction Model

This program was designed to assist in computer utilization prediction. The method used in developing the model to predict the computer utilization was to forecast (1) the utilization of each component series separately, (2) based on past utilization records. The aggregation of the component series utilization predictions would then produce a more accurate utilization prediction. In a component aggregation such as this, the errors in prediction tend to cancel each other.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 SERIES
PROGRAM SIZE: Approximately 470 source statements
PRICE: Program \$90.00 Documentation \$5.50
PROGRAM NUMBER: MFS-22688

Merge and/or Modify Tabular Data Computer Program

In some analysis programs it is often necessary to determine the effects of variations in the tabular input data. This program can modify an existing data deck, with a minimum of additional input data. In addition, two existing card decks can be altered and merged to form a new card deck. The changes which can be accomplished are shown below: (1) The independent variable can be biased (±) on one or two decks. (2) The dependent variables of these decks can be added or subtracted to form a new set. (3) The dependent variables can be multiplied by a constant factor and/or a term (±) can be combined (again, on two new sets and combined if desired).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 62 source statements
PRICE: \$35.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MFS-24360

FORTRAN Read Package

The lack of a flexible input scheme in many large digital programs becomes a problem to both program users and programmers. Many input schemes require card formats, a fixed card order, or a specific number of cards. These requirements make program usage cumbersome and error prone. MThe use of this read package offers the following advantages. No card format or special order of cards is required. The package is controlled by a small set of parameters which can be changed to account for differences in computers and digital programs. The parameter's location in COMMON is used to identify the parameter. This location number is placed anywhere in the first five columns on the data card. The value of the parameter is placed anywhere on the rest of the card and followed by an asterisk. Sequential locations may be defined on the same card. The read package determines what type of parameter is being defined and automatically

differentiates between integer, real, octal, and Hollerith input. The program has the following capabilities: (1) Times may be input in HR/MIN/SEC or MIN/SEC: (2) Aside from FORTRAN F- or E-type input, the package accepts Hollerith, octal, and double precision input: (3) The capability to specify any parameter in COMMON for printing is provided; Multiple designation may be used to set an entire array equal to the same value; (5) Comments may be intermixed with data to identify input; (6) Continuations from one card to another are allowed during sequential input; (7) A sophisticated error checking capability is provided; and (8) The read package is written entirely in FORTRAN IV and can be used on any computer no matter how many bits are used to define one computer word. A routine has been included in the Read Package which is not used during the input phase. This routine is called SPECPR and has been included to allow the printout of any parameters in COMMON. This routine can be added to the print routine of any program and, when used in conjunction with the Read Package, allows parameters to be specified for printing from input.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 709 source statements
PRICE: Program \$260.00 Documentation \$2.50
PROGRAM NUMBER: MSC-14161

Hewlett-Packard 65 Emulator

The HP-65 Emulator was designed to aid in the development and checkout of programs written for the Hewlett-Packard Model 65 Programmable Pocket Calculator. The HP 65 Emulator simulates on a large computer a user defined HP-65 program. The diagnostic aids offered by the emulator help reduce development and checkout time and the automated documentation reduces bookkeeping and improves the reliability of the documentation task. The Emulator consists of a processor, and executor and a set of library routines. The processor converts the HP-65 program, as defined on input data cards, into a Fortran program which is then compiled, the executor executes this program as requested by the user through run control cards, and the library supplies the basic functions requested by the program, such as trigonometric, logarithmic, and exponential functions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS. CDC 6000 Series
PROGRAM SIZE: Approximately 1,700 source statements
PRICE: Program \$340.00 Documentation \$7.00
PROGRAM NUMBER: MSC-14815

CONSTAT - A Program For Concordances and Statistics

CONSTAT was conceived as a literary research tool which would serve a variety of users and provide a concordance and every conceivable textual statistic that might be desired for authorship ascription and determination of sequence of composition. It has since proved useful as an aid to proof-reading, indexing, and stylistic and vocabulary analyses. It is readily adapted to automatic key word extraction of machine-readable text. An objective has always been to achieve the utmost in economy of machine time. Thus, once machine-readable text is available, many mechanical textual manipulations can be economically performed. During the process of composition, for example, one may maintain a running index of what one has written and the total number of words. The program may also be used to search through machine readable material to find desired passages or to determine whether the material is of interest. Though the manipulation of the text is strictly mechanical, the concordance thus obtained is quite useful and the statistics produced are the ones most commonly used in textual analyses. For statistical validity, more than usual emphasis is placed on the importance of the common words. These latter occur in large numbers and thus form a more reliable basis for statistical inference as to authorship or chronology. The program has provisions (such as for upper case). It will not, in general, be necessary to adapt existing machinereadable text to the program. A wide variety of outputs are offered. All data may be obtained through the printer. statistical distribution curves may be plotted and both tape and card output may be obtained of the concordances of the works of one writer or of several writers, or one may wish to make correlations of the statistics of several texts to determine most probable authorship or sequence of composition.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE. Approximately 1,356 source statements
PRICE: Program \$200.00 Documentation \$17.00
PROGRAM NUMBER: MSC-17484

CHANGE-FORTRAN IV Digital Program Change

This program is used to modify FORTRAN IV source language programs to aid in their debugging, checkout, and final documentation. Three modifications may be accomplished: (1) rearrangement and incrementing of statement numbers. (2) insertion of card identification and sequencing, (3) insertion aid/or removal of end-of-batch symbols. The program is designed to allow the user to modify his program without sacrificing turnaround time. Thus, the user has the option to compile, link edit, and execute the modified program as a normal run. There are other programs available that have the rearrangement and incrementing features but the automatic sequencing of statement numbers and insertion of end-of-batch symbols are assumed to be original.

LANGUAGE: ASSEMBLER (75%); FORTRAN IV (25%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 2,104 source statements
PRICE: Program \$310 00
PROGRAM NUMBER: MSC-17567

Indices and Cross References From Computer Readable Text

This program was developed to provide indices and cross reference tables from computer readable texts. The program will produce an index on selected words or phrases. The program will search the text and reference all occurrences of the specific words or phrases used as search keys. This program has been configured to process Administrative. Terminal Service. (ATS) generated texts. The program will operate with the Time Share Option (TSO) or on batch processing computers.

LANGUAGE: PL1
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE. Approximately 97 source statements
PRICE: \$50.00
NOTE. The program price includes the documentation and
a program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MSC-19423

3-D Plotting Program, HP 9820A

. This procedure allows any 3 dimensional object to be rotated to any angle in any view and plotted (drawn). The plot can be made of the object from top view, side view or end view and if desired, all three views can be plotted on one piece of paper. Dynamics have not been included and this program does not suppress lines which define the far side of the object.

LANGUAGE: Not Applicable
MACHINE REQUIREMENTS: Hewlett-Packard 9820A

Hewlett Packard 9862A

PROGRAM SIZE: Not Applicable

PRICE: \$45.00

NOTE: The documentation price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MSC-19460

Contour Flotting, FORTRAN IV Subroutines

These FORTRAN IV subroutines are designed to produce a contour graph for a user-coded bivariate function. The routines are independent of the specified plotting equipment and; therefore, can be used with basic plotting subroutines for any equipment. A grid scanning approach is used rather than a curve-following method. Resolution depends entirely on the fineness of the grid specified by the user. Since a curve following method must include some form of scanning to avoid missing isolated curves, it is believed that the approach used here is more efficient than curve following when graphic display is the desired end-product. For applications requiring extreme precision, the contours produced as above could be refined by gradient methods or by reapplication of the routine, using a finer grid on smaller regions containing the curves of interest. The number of function evaluations, NX x NY, is fixed by the user's specification of NX and NY and, in particular, is independent of the number of different contour values requested. It is not necessary to be able to store the entire matrix of NX x NY grid values simultaneously. An array of (NX + 2) words provides all the space needed to save values at grid points. The construction of contour strings uses list-processing techniques, so it is not necessary to anticipate the number of distinct contour curves or the number of points per curve. If the storage available for the contour strings becomes exhausted, the subroutine interrupts processing so that the strings can be sent to the basic plotting subroutines before processing is resumed

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-7090/7094, SC 4020 plotter PROGRAM SIZE: Approximately 938 source statements PRICE: Program \$140.00 Documentation \$12.00 PROGRAM NUMBER: NPO-10127

SFTRAN-Structured Programming to Fortran Translator

The program SFTRAN (Structured Programming to Fortran Translator) was written to allow Fortran programmers to use the logical control elements of structured programming. These elements include the fundamental syntactical elements IF() THEN, ELSE, and DO WHILE as well as certain other elements supplied for user convenience such as PROCEDURE declarations, DO UNTIL, DO CASE and DO FOR. Because the Fortran language does not recognize the basic language structures used in structured programming, SFTRAN is a translator that converts structured programming source statements into Fortran statements acceptable to the Fortran compiler. The source code distributed by COSMIC for SFTRAN is written in structured Fortran, however the executable code for SFTRAN is also recorded on the distribution magnetic

LANGUAGE: SFTRAN MACHINE REQUIREMENTS: Univac 1100 Series PROGRAM SIZE: Approximately 680 source statements DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Format-Documentation \$9.00

PRICE: Program \$380 00 PROGRAM NUMBER: NPO-13602

FLOWCHARTER --- Program For Producing Flow Charts of Fortran Source Decks, GE-635 Version

The Flo Chart program is designed to produce flowcharts of programs written in FORTRAN IV or FORTRAN II. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the program under consideration. This program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: GE 635 PROGRAM SIZE: Approximately 591 source statements PRICE: Program \$160 00 Documn lation \$5.00 PROGRAM NUMBER: WLP-10030

3-D Plotting Program, HP 9820A

. This procedure allows any 3 dimensional object to be rotated to any angle in any view and plotted (drawn). The plot can be made of the object from top view, side view or end view and if desired, all three views can be plotted on one piece of paper. Dynamics have not been included and this program does not suppress lines which define the far side of the object.

LANGUAGE: Not Applicable

MACHINE REQUIREMENTS: Hewlett-Packard 9820A

Hewlett-Packard 9862A

PROGRAM SIZE: Not Applicable

PRICE: \$45.00

NOTE: The documentation price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: MSC-19460

Contour Plotting, FORTRAN IV Subroutines

These FORTRAN IV subroutines are designed to produce a contour graph for a user-coded bivariate function. The routines are independent of the specified plotting equipment and; therefore, can be used with basic plotting subroutines for any equipment. A grid scanning approach is used rather than a curve-following method. Resolution depends entirely on the fineness of the grid specified by the user. Since a curve following method must include some form of scanning to avoid missing isolated curves, it is believed that the approach used here is more efficient than curve following when graphic display is the desired end-product. For applications requiring extreme precision, the contours produced as above could be refined by gradient methods or by reapplication of the routine, using a finer grid on smaller regions containing the curves of interest. The number of function evaluations, NX x NY, is fixed by the user's specification of NX and NY and, in particular, is independent of the number of different contour values requested. It is not necessary to be able to store the entire matrix of NX x NY grid values simultaneously. An array of (NX + 2) words provides all the space needed to save values at grid points. The construction of contour strings uses list processing techniques, so it is not necessary to anticipate the number of distinct contour curves or the number of points per curve. If the storage available for the contour strings becomes exhausted, the subroutine interrupts processing so that the strings can be sent to the basic plotting subroutines before processing is rèsumed.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-7090/7094, SC 4020 plotter PROGRAM SIZE: Approximately 938 source statements PRICE Program \$140.00 Documentation \$12.00 PROGRAM NUMBER: NPO-10127

SFTRAN—Structured Programming to Fortran Translator

The program SFTRAN (Structured Programming to Fortran Translator) was written to allow Fortran programmers to use the logical control elements of structured programming. These elements include the fundamental syntactical elements IF() THEN, ELSE, and DO WHILE as well as certain other elements supplied for user convenience such as PROCEDURE declarations, DO UNTIL, DO CASE and DO FOR Because the Fortran language does not recognize the basic language structures used in structured programming, SFTRAN is a translator that converts structured programming source statements into Fortran statements acceptable to the Fortran compiler. The source code distributed by COSMIC for SFTRAN is written in structured Fortran, however the executable code for SFTRAN is also recorded on the distribution magnetic

LANGUAGE: SFTRAN MACHINE REQUIREMENTS: Univac 1100 Series PROGRAM SIZE: Approximately 680 source statements DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Format-PRICE: Program \$380 00 Documentation \$9.00 PROGRAM NUMBER: NPO-13502

FLOWCHARTER---Program For Producing Flow Charts of Fortran Source Decks, GE-635 Version

The Flo Chart program is designed to produce flowcharts of programs written in FORTRAN IV or FORTRAN II. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the program under consideration. This program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 591 source statements
PRICE: Program \$160.00 Docume tation \$5.0 Documn lation \$5.00 PROGRAM NUMBER: WLP-10030

ELECTRONICS

Includes electronic circuit design and analysis; design and development of basic electrical and electronic components; feedback and control theory.

VASP—Variable Dimension Automatic Synthesis Program

VASP is a Variable dimension Fortran version of the Automatic Synthesis Program called ASP. The program is used to implement the Kalman filtering and control theory Basically, it consists of a 31 subprograms for solving night modern control problems in linear, time-variant to time invariant) control systems. These subprograms include operations of matrix algebra, computation of the exponential of a matrix and its convolution integral, and the solution of the matrix Riccati equation. The user calls these subprograms by means of a FORTRAN main program, and so can easily obtain solutions to most general problems of extremization of a quadratic functionat of the state of the linear dynamical system. Particularly, these problems include the synthesis of the Kalman filter gains and the optimal feedback gains for minimization of a quadratic performance index. The VASP is an outgrowth of ASP and has the following improvements: (1) more versatile programming language; (2) more convenient input/output format; (3) some new subprograms which consolidate certain groups of statements that are often repeated; and (4) variable dimensioning. The pertinent difference between the two programs is that VASP has variable dimensioning and a more efficient storage. The documentation for the VASP program contains a VASP dictionary and some example problems. The dictionary contains a description of each subroutine and instructions on its use. The example problems include dynamical response, optimal control gain, solution of the sampled data matrix Ricatti equation, matrix decomposition, and a pseudo inverse of a matrix.

LANGUAGE: FORTRAN IV. H LEVEL compiler MACHINE REQUIREMENTS: Tested on IBM 360/67 TSS PROGRAM SIZE: Approximately 2,259 source statements PRICE: Program \$590.00 Documentation \$15.00 PROGRAM NUMBER: ARC-10616

AUTOWIRE---- IBM-360 Version

The AUTOWIRE/360 program is used to assist the logic designer in the translation from his original design to the finished translation from his original design to the finished translation. The assistance is in the form of diagnostic tests, module placement guides, and machine instruction cards to drive the Gardner-Denyer Automatic Wire-Wrap machine. The hardware is in the form of six socket pariels mounted on an aluminum frame. A total of

360 14 pin dual in-line packaged integrated circuits may be plugged into the six boards and interconnected by the AUTOWIRE/360 program. The wired frames are mounted in multiple in conventional rack type drawer assemblies. Although the program is designed for a particular panel assembly, it may easily be modified to support similar panel/socket assemblies. Program documentation consists of a user's guide, programmer's guide, operator's guide, and logic designer's guide.

LANGUAGE: FORTRAN IV (98.8%): ASSEMBLER (1.2%) MACHINE REQUIREMENTS: IBM:360 PROGRAM SIZE. Approximately 4,553 source statements PRICE: Program \$840.00 Documentation \$36.00 PROGRAM NUMBER: GSC-11526

Puzzle---Computer Aided Design

This program package represents engineering design software. It is a single program which is applicable to problems of designing printed circuit boards and is capable of designing two-sided boards with a variety of components. The technique of man-machine interaction is used in which the designer retains control over certain design decisions while the computer solves topological problems and furnishes graphic output suitable for printed circuit production. This technique of man-machine interaction has the advantage of minimizing costly computer time necessary for the completion of a circuit card. Restrictions of the programs are: (1) path lengths are not minimized, the routing logic tends to produce short paths but no effort is made to assure that they are the shortest paths possible; (2) through holes are not minimized, (a smoothing routine tends to reduce the number of holes carrying lines back and forth through the surfaces of the board, but the algorithm does not minimize them); (3) solutions to portions of the topological routing may be incomplete, requiring innecessary jumpers or touch-up of the artwork. Also the pen and ink drawings are produced by a Cal Comp Plotter and may be used to produce prototype circuit boards by direct reproduction, but if the high quality needed for a production run is to be produced an optical plotting system is needed. In this case, a Gerber optical plotting system has been used to plot PUZZLE output. It produces high quality film positives directly. The program operates in interactive mode and though it is presently written for CDC 6000 Series machines. It is written entirely in FORTRAN IV and it would be reasonably

ELECTRONICS

Includes electronic circuit design and analysis; design and development of basic electrical and electronic components; feedback and control theory.

VASP—Variable Dimension Automatic Synthesis Program

VASP is a Variable dimension Fortran version of the Automatic Synthesis Program called ASP. The program is used to implement the Kalman filtering and control theory Basically, it consists of a 31 subprograms for sol, agricust modern control problems in linear, time-variant re-time invariant) control systems. These subprograms include operations of matrix algebra, computation of the exponential of a matrix and its convolution integral, and the solution of the matrix Riccati equation. The user calls these subprograms by means of a FORTRAN main program, and so can easily obtain solutions to most general problems of extremization of a quadratic functional of the state of the linear dynamical system. Particularly, these problems include the synthesis of the Kalman filter gains and the optimal feedback gains for minimization of a quadratic performance index. The VASP is an outgrowth of ASP and has the following improvements: (1) more versatile programming language; (2) more convenient input/output format; (3) some new subprograms which consolidate certain groups of statements that are often repeated; and (4) variable dimensioning. The pertinent difference between the two programs is that VASP has variable dimensioning and a more efficient storage. The documentation for the VASP program contains a VASP dictionary and some example problems. The dictionary contains a description of each subroutine and instructions on its use. The example problems include dynamical response, optimal control gain, solution of the sampled data matrix Ricatti equation, matrix decomposition, and a pseudo inverse of a matrix.

LANGUAGE: FORTRAN IV. H LEVEL compiler MACHINE REQUIREMENTS: Tested on IBM 360/67 TSS PROGRAM SIZE: Approximately 2,259 source statements PRICE: Program \$590.00 Documentation \$15.00 PROGRAM NUMBER: ARC-10616

AUTOWIRE-IBM-360 Version

The AUTOWIRE/360 program is used to assist the logic designer in the translation from his original design to the finished hardware. The assistance is in the form of diagnostic tests, module placement guides, and machine instruction cards to drive the Gardner Jenyer Automatic Wire-Wrap machine. The hardware is in the form of six socket panels mounted on an aluminum frame. A total of

360 14-pin dual in line packaged integrated circuits may be plugged into the six boards and interconnected by the AUTOWIRE/360 program. The wired frames are mounted in multiple in conventional rack-type drawer assemblies. Although the program is designed for a particular panel assembly, it may easily be modified to support similar panel/socket assemblies. Program documentation consists of a user's guide, programmer's guide, operator's guide, and logic designer's guide.

LANGUAGE: FORTRAN IV (98.8%): ASSEMBLER (1.2%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE. Approximately 4,553 source statements
FRICE: Program \$840.00 Documentation \$36.00
PROGRAM NUMBER: GSC-11526

Puzzle-Computer Aided Design

This program package represents engineering design software. It is a single program which is applicable to problems of designing printed circuit boards and is capable of designing two-sided boards with a variety of components. The technique of man-machine interaction is used in which the designer retains control over certain design decisions while the computer solves topological problems and furnishes graphic output suitable for printed circuit production. This technique of man-machine interaction has the advantage of minimizing costly computer time necessary for the completion of a circuit card. Restrictions of the programs are: (1) path lengths are not minimized, the routing logic tends to produce short paths but no effort is made to assure that they are the shortest paths possible; (2) through holes are not minimized, (a smoothing routine tends to reduce the number of fioles carrying lines back and forth through the surfaces of the board, but the algorithm does not minimize them); (3) solutions to portions of the topological routing may be incomplete, requiring tinnecessary jumpers or touch-up of the artwork. Also the pen and ink drawings are produced by a Cal Comp Plotter and may be used to produce prototype circuit boards by direct reproduction, but if the high quality needed for a production run is to be produced an optical plotting system is needed. In this case, a Gerber optical plotting system has been used to plot PUZZLE contput. It produces high quality film positives directly. The program operates in interactive mode and though it is presently written for CDC 6000 Series machines. It is written entirely in FORTRAN IV and it would be reasonably

convenient to convert the program for use on other machines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series with Cal
Comp Plotter (see abstract)
PROGRAM SIZE: Approximately 2,427 source statements
PRICE: Program \$700.00 Documentation \$14.50
FROGRAM NUMBER: GSC-11947

AUTOSKEM I—Automatic Electronic Schematics Program

This program package represents a utility program for drawing electronic schematics on a digital plotter. Schematic symbols included are lead, circle, arc, ground, ncde, number, resistor, capacitor, inductor, battery, AC sources, diodes, and transistors. The program can draw either a 'B' or 'C' size drafting paper outline and has been designed to be used by personnel with no prior computer programming knowledge. A high degree of versatility is allowed by the program and constraints are few. The program operates in batch mode and requires the availability of two 7 track tape units and a Calcomp plotting package.

LANGUAGE: FORTRAN IV (95%) MAP (5%)
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,558 source statements
PRICE: Program \$570.00
PROGRAM NUMBER: GSC-11948

SEE—Systems Effectiveness Evaluation Computer Program

A system of eight integrated computer programs has been developed to assess the effectiveness of any complex electronic system. The programs were originally developed to assess the reliability and maintainability of twelve sets of Acceptance Checkout Equipment/Spacecraft ZAEC-S/C), each set containing 175 racks of equipment and 1,000 price parts. Input to the System Effectiveness Evaluation (SEE) Programs consists of system configuration data, elapsed time meter readings and edited failure reports. The outputs of the SEE Programs are: (a) Mean-Timesbetween-Failures (MTEF) and Mean-Times-To-Repair (MTTR) for all unique parts of assemblies, for all subsystems and for the system, with associated confidence parameters and flagging of weak links. (b) Printer-plotter trend charts of the MTBF's and MTTR's. (c) MTBF and MTTR correlation charts comparing performance of all ground stations. (d) Computation of system reliability, availability and expected cumulative downtime during a simulated mission. (e) Numerous utility programs used in spares prediction and to assist in identification of problem areas. Proper and timely integration of three separate and distinct data areas are essential for desired results: A set of translation tables to precisely encode the complete logical description of all equipment to be assessed; systematic reporting and processing of failure experience; periodic recording and processing of equipment operating time. The primary feature of the SEE Program is the ability to rapidly pin-point equipment problem areas for corrective action down to the lowest possible level of assembly. The programs can be modified to us utilized by any large complex electronic system.

LANGUAGE: FORTRAN (67.65%); GMAP (32.35%)
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 12,175 source statements
PRICE: Program \$1,000 0 Documentation \$21.00
PROGRAM NUMBER: HQN-10306

ASAP---Automated Statistical Analysis Program

ASAP (Automated Statistical Analysis Program) was designed to perform a Monte Carlo statistical analysis on the dic currents and voltages of transistor and diode circuits. It was intended that the ASAP user be required only to provide a simple topological description of the circuit in an English-text form. The ASAP program, through a pattern-recognition subprogram, scans and analyzes input data, producing a table which indicates the sections of this data. The program then uses this data to write a set of Kirchoff equations and then solves them algebraically using the Gauss reduction method. ASAP will build a mathematical model of the circuit and its nonlinear components, then a subroutine will perform the statistical analysis. The topological description the circuit may include resistors, voltage sources, current ces, diodes, and transistors. The diodes and transistors are represent ed by voltage-current tables supplied as input data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 5,000 source statements
PRICE: Program \$530.00 Documentation \$10.00
PROGRAM NUMBER: LAR-11125

STICAP—Linear Circuit Analysis Program with Stiff Systems Capability

Most computer aided network analysis programs are designed to relieve the user of the following burdens: (a) Circuit translation - the obtaining of the differential and algebraic equations governing the network, starting from an easily specified description of the circuit in the terminology of the network designer, and (b) Numerical integration - the obtaining of a numerically accurate solution of the initial value problem for this set of circuit equations. The present state of the art allows a reasonably effective solution of the former problem. However, most first generation circuit analysis programs are somewhat restricted in scope, as regards the latter, in the instance of stiff networks which are characterized by widely separated time constants. In such circumstances the numerical integration techniques implemented in the first versions of programs like CEPTRE and ECAP require such prohibitively small time steps that they become impractical as aids to analysis. The primary reason for the design of STICAP is the motivation to combine the capabilities of circuit translation using the state variable topological approach with efficient numerical integration techniques for transient analysis, using algorithms which possess both stiff and non-stiff capabilities. The STICAP program is restricted to the analysis of linear time invariant networks. It represents a merging, with some modifications to each, of Pottle's circuit analysis program CORNAP with Gear's program ALGORITH 407 - DIFSUB, for the automatic integration of ordinary differential equations. The program package is best viewed as consisting of three seperate components, or modes of operation, each having some advantages and disadvantages over the others in different circumstances. In each mode the common method of circuit translation is that originally employed in program CORNAP; a topological approach the result of which is a set of first order linear differential equations governing the time evolution of the circuit state variables. The CORNAP mode makes selectable the program CORNAP with all previous capabilities, but optional selection of certain data printing features. These capabilities include calculation of transfer functions, zeroes of transmission, frequency and time response of the circuit. The fourth order numerical integration algorithm implemented in CORNAP for time domain analysis is absolutely stable; hence, it may be used for either stiff or non-stiff networks. However, the stepsize is fixed throughout the duration of computation, a feature which can be uneconomical in some instances. Further, other than impulse or step functions, the only type of circuit input is sampled data. The Gear and Matrix modes may be used to compute time domain transient, impulse, or step responses only, with the option of calling CORNAP subroutines to obtain transfer functions and zeroes of transmission. The Gear mode allows the selection of either an Adam's integration method, suitable for non-stiff equations, or else the methods of Gear, suitable for stiff equations. This mode can be used for analysis of the general linear time invariant network, with forcing functions specified using the full power of the FORTRAN language, or by means of sampled data. In both cases, automatic order selection techniques and variations in the step size are employed as the integration preceeds, to achieve a desired level of accuracy with the minimum number of integration steps. The maximal order truncation error selectable by changing from one algorithm to another via the automatic order selection process is an eighth order Adam's method or a sixth order stiff algorithm. In the matrix mode, a special decomposition of the system matrix in terms of its eigenvalues is employed, to obtain a closed form solution which avoids a numerical integration. The resulting method is computationally rapid and may be used for either stiff or non-stiff networks; however, it is applicable only in the case of no repeated eigenvalues of the system matrix, and for systems whose forcing functions are linear combinations of sinusoidal, cosinasoids, impulse, or step functions.

LANGUAGE: FORTRAN IV
MACHINE REQU!*.cMENTS. CDC 6000 Series
PROGRAM SIZE: Approximately 9,268 source statements
PRICE: Program \$1,440.00 Documentation \$24.50
PROGRAM NUMBER: LAR-11184

Design of Microstrip Components by Computer

This study presents a number of computer programs used in the synthesis of microwave components in microstrip geometries. The programs compute the electrical and dimensional parameters required to synthesize couplers, filters, circulators, transformers, power splitters, diode switches, multipliers, diode attenuators and phase shifters. Additional programs are included to analyze and optimize cascaded transmission lines and lumped element networks, to analyze and synthesize Chebyshev and Butterworth filter prototypes, and to compute mixer intermodulation products. This group of programs can be divided into component synthesis and design programs. The single strip programs include synthesis of low pass filters, lumped high pass filters, microstrip stopband filter, stepped impedence transformer, hybrid ring and finite circulator. The coupled microstrip lines include end coupled bandpass filters, parallel coupled bandpass filters, microstrip directional coupler and hybrid T synthesis. Design aids include the Chetyshev response. spurious intermodulation products, and analysis/optimization. Multiplier design aids are diode characteristics and analysis, output and idler circuits, and the microstrip tripler. This is a very complete and comprehensive system that would be useful to any environment requiring design or analysis of microstrip components.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: CDC 6000 Series

PROGRAM SIZE: Approximately 6,000 source statements PRICE: Program \$950.00 Documentation \$15.50 PROGRAM NUMBER: LAR-11220

Computarized Technique for Documenting Complex Wiring

This software package is an electrical engineering program developed for documenting the wiring interconnections in complex electrical systems. This computerized technique eliminates the need for drafting numerous detailed wiring diagrams, and the attendant problems of keeping them up to date with the many changes which often occur during development and testing. The characteristics and functions of each conductor in the eletrical system are input to the program. Each component is assigned a unit number and a sequential signal number identifies all conductors from each unit. The output tabulations include each conductor with both termination points; and a brief description of the function of the conductors in the system are given. The output wire lists show the origin of each conductor, its destination, the cable designation number, and the electrical characteristics of the circuit. The program is particularly adaptable to complex systems where a large number of components are to be interconnected. The program operates in batch mode

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 472 source statements
PRICE: Program \$330.00 Documentation \$7.00
PROGRAM NUMBER: LEW-11749

ECAP---Electronic Circuit Analysis Program, IBM 360 Version

The Electronic Circuit Analysis Program (known as ECAP) is an integrated system of programs designed to aid the electrical engineer in the design and analysis of electronic circuits. This system of programs can produce DC, AC, and/or transient analyses of electrical networks from a description of the connections of the network (the circuit topology), a list of corresponding circuit element values, a selection of the type of analysis desired, a description of the circuit excitation, and a list of the output desired. ECAP recognizes a set of standard electrical circuit elements. Any electrical network that can be constructed from any or all of the different elements in the set can be analyzed by ECAP. There is almost no limit to the number of ways that the circuit elements can be arranged in the network. The set of standard circuit elements does not include electronic components, but in many cases, these components are easily simulated by means of equivalent circuits constructed of standard elements. A number of examples are included in this manual that involve the use of equivalent circuits. ECAP allows the circuit designer to economically and efficiently examine the performance of a circuit during the various stages of its design, by using a computer rather than a "breadboard." In this way, the designer can rapidly determine the variations in circuit response that correspond to change in circuit parameters. Studies can be made of circuits that contain costly components that may be difficult to obtain. Destructive excitation can be applied to the circuit with no lear of destroying expensive electronic circuit elements. Worst case combinations, which are hard or practically impossible to realize in the laboratory, can be examined. Measurements that may be difficult to make, and time consuming to instrument, can

be made quite simply on the computer. Circuit connections can be changed rapidly. In many cases, ECAP can leave the designer with a clearer insight into the operation of the circuit than could be obtained with a breadboard study, and often at considerably less cost.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 360/370, CDC 6000

Series, UNIVAC 1100 Series

PROGRAM SIZE: IBM Vers - Approximately 5600 source statements

CDC Vers - Approximately 10,000 source statements UNIVAC Vers - Approximately 7,000 source statements PRICE: IBM Vers - Program \$820.00 — Documentation

\$19.00

CDC Vers - Program \$600.00 Documentation \$9.50 UNIVAC Vers - Program \$630.00 Documentation \$8.50

PROGRAM NUMBERS: IBM Vers. - MFS-13094

CDC Vers. - LEW-10667 UNIVAC Vers. - NPO-11412

CIRCUS—A Digital Computer Program for Transient Analysis of Electronic Circuits

This program is designed to simulate the time domain of response of an electronic circuit to an arbitrary forcing function. CIRCUS uses a charge control parameter model to represent each semiconductor device. When given the primary photocurrent induced in the semi-conductor devices, the transient behavior of a circuit in a radiation environment can be determined. The program initially sets up time-domain circuit equations from a topological description of the network. Steady-state initial conditions are found by setting the differential equations to zero, then evaluating the transient solution by numerical integration of the differential equations. The program output includes the input data and columnar listings of network variables vs. time. Virtually any current variable including currents and voltages internal to the semiconductor devices, may be displayed. Although no plotting capability is ordinarily supplied with CIRCUS, provisions have been made for saving variables on tape for subsequent piotting or further analysis by other programs

LANGUAGE: FORTRAN H (931), ASSEMBLER (7%)
MACHINE REQUIREMENTS 18M 360
PROGRAM SIZE Approximately 6,987 source statements
PRICE: Program \$700.00 Documentation \$23.00
PROGRAM NUMBER: MFS-15002

MPP—Control Program to Determine Minimum Phase from Variable Gain Characteristics

In designing control systems, it is required to design a passive electrical network which satisfies specified gain and phase characteristics. It is assumed that a passive network can be constructed whose corresponding transfer function reflects stability of the network. If the minimum phase lag associated with a specified gain characteristic is less than a desired phase lag, then an actual electrical network can be constructed which will satisfy both gain and phase characteristics set forth by the engineer. The Minimum Phase Program determines the minimum phase or of passive electrical networks reflecting the degree a stability of the transfer functions basically esta it and by the gain characteristics determined by the engiller in the program input. The phase lag is determined in the program as a function of frequency for a specified gain characteristic. To describe gain characteris tics, the program user inputs a tabular array of gain versus frequency and two slopes. The slopes are used to define the gain curve for frequencies before and after the frequencies in the tabular defined region. The slopes are imputs. The integration technique employed is the trapezoidal method and the integration can be expressed as a function of frequency. The limits of integration are computed from a fraction and multiple which are multiplied by each off frequency value. The fraction and multiple integration limits are user input. The accuracy of the technique depends primarily on the increment used to form the base of each trapezoid. The user can divide the curve into three regions, each with its own frequency increment. The frequency increments are also user input.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE. Approximately 412 source statements
PRICE: Program \$380.00 Documentation \$7.00
PROGRAM RUMBER: MFS-15045

Computerized Logic Design of Digital Circuits

A computerized togic design procedure is presented for a specially developed computer program that performs all the work required for the logic design of digital counters of sequential circuits and the simplification of Boolean expressions. The program provides a simple, accurate, and comprehensive logic design capability to users both experienced and totally inexperienced in logic design. The program has been developed for two modes of operation: Counter design and Boolean simplification. In the counter design mode, the program provides the simplified flip flop input equations for any desired sequence and using in either sum of product or product of sum form for any one or all of the flip flop types. The program also provides printout of the intermediate design steps used in obtaining the thip flop input equations. In the Boolean simplification mode, the program simplifies Boolean logic functions that can be entered meither sum of product or product of sum form. The counter design mode can also be used for design of sequential circuits other than counters. The program can be used for any sequential design application. where a group of flip flops are required to change states in a prescribed order. Another useful feature of the program. is that for a given count sequence, the counter design equations can be obtained for several or all of the available type flip flops. The designer can compare these equations for simplicity or some other desired characteristic and select the optimum type flip flop for the given sequence. Considerable effort was expended in the development of these programs to reduce the input data requirements to the simplest level possible and to present the output results in a self-explanatory and instructive format

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC 1108
PROGRAM SIZE: Approximately 1,067 source statements
PRICE: Program \$710.00
PROGRAM NUMBER: MF5-22401

Tolerance Analysis Program

This program can be used to determine the mean and telerance values of an end to end signal chain or flow path. Unlike many tolerance determination techniques, this program does not assume the nature or shape of the individual building block or circuit element probability density functions (PDF). Instead, it takes known circuit element hardware test data, which may be in the form of a histogram, or specified as a nominal value with an associated set of limits, and statistically sums the PDF's of the individual circuit elements into overall PDF for the

complete end to-end signal path. From this overall PDF, a set of limits is computed which contains a desired and preselected amount of probability included between these limits. This program is particularly well-suited for defining the tolerances to be specified in procurement or test specifications, as well as having a utilitarian value in the synthesis and analysis phases of the subsystem design process.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,400 source statements
PRICE: Program \$570.00 Documentation \$12.00
PROGRAM NUMBER: MSC-17487

Wire Chain Program, UNIVAC-1108 Version

The Wire Chain Program is of use to anyone doing complicated electrical/electronic circuit layout or design involving either wired or printed circuit routing. It provides a listing of the contents of given electrical chains. A chain is a group of links (wire between two pin points) which are tied together electrically, and a listing of links which are not tied electrically. The program requires three types of input data: control, chain vertex (starting vertex of a giver, chain), and link data. The program determines the format, the source of the link input and what type of output is required from the control data card. The chain vertices are read in and initial the condition set up. As many as 50 chain vertices during one run can be handled by the program and there can be N number of links.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS. UNIVAC-1108
PROGRAM SIZE: Approximately 1.026 source statements
PRICE: Program \$140.00
Documentation \$2.50
PROGRAM NUMBER: NPO-11332

MTRAC——Computer Program for Analysis of Circuits Including Magnetic Cores

Transient analysis of circuits that include magnetic cores is complicated by the nonlinearity of the switching-core model and by the magnetic coupling among the loop currents. These difficulties have been overcome by incorporating static and dynamic cure models into the automated circuit analysis computer program TRAC. The program has been modified by including provisions for successive modes of operation, conditional monitor

printout of variable values in different portions of the program, plot and print-plot routines with external or internal specifications for scales, units, and frame sizes, normal and circuit-failure run termination, nonlinear inductor and resistor models, etc. The modified computer program is named MTRAC. Time variables (voltages, currents, MMF's, fluxes, etc.) of complex magnetic-core circuits (up to 60 nodes can thus be computed and plotted automatically. All that the user has to supply is the general run-control specifications, the circuit topology, and the values of the circuit-element parameters. The MTRAC program consists of two sections, one dealing with initialization, and the other with the transient solution. The initialization section performs the following five tasks: (1) Read in and print out general input data, (2) Read in and print out the circuit-element data, (3) Solve initial conditions (optional). Print out and store initial conditions, and (5) Read in and print out continued run-data (optional). The transient-solution section performs the following seven tasks: (1) Compute the magnitudes of the time-variable current and voltage sources, (2) Until convergence is achieved, compute by iterations (using a routine for solving matrix equations and a modified Newton-Raphson method for solving matrix equations and a modified Newton-Raphson method for solving transcendental equations) all the nodal voltages and all the currents through the nonlinear elements (diodes, transistors, and magnetic-core windings); if necessary reset the unknown values and cut the time step. -t, (3) Compute the currents through the linear elements, (4) Adjust -t according to the recent convergence conditions and update the time variables for the next -t, (5) Store (for plots) and print out the resulting time variables, (6) If the run-time limit is about to be exceeded, punch the final results necessary for a future continued run on cards, and (7) Print-plot the specified variable waveforms and store the plot data on a tape, begin a new mode, or exit. Instructions for data entry by the user are provided. These include definitions of special functions and/or auxiliary variables, and input data cards specifying the run control and the circuit-element topology and parameter values. The MTRAC program has been applied successfully to transient analyses of several magnetic-core circuits.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 5,750 source statements
PRICE: Program \$920.00 Documentation \$25.00
PROGRAM NUMBER: NPO-11494

FACILITIES. RESEARCH AND SUPPORT

Includes simulators and simulation methods; test facility and test equipment design and operation; cost effectiveness, examination and selection of equipment, materials, personnel, and methods for optimum performance of tasks; support facility administration, management and inventory control.

Digital Program for Solving the Linear Stochastic Optimal Control and Estimation Problem

This problem is a mathematics package containing fourteen subroutines to solve the linear stochastic optimal control and estimation (LOSCHE) problem. The program subroutines are largely implementations of published algorithms which were previously unavailable as computer programs. The solution to the LSOCE problem is a Kalman filter, which estimates the system states, coupled through a set of optimal regulator gains to produce the desired control signal. The key to solving the LSOCE problem is the solution of the matrix Riccati differential equation. This equation occurs in solving for both the finite time optimal linear regulator gains and the finite time optimal linear estimator (Kalman filter) gains. An important special case is the finite time LSOCE problem, in which the main equations to be solved use algebraic (steady state) matrix Riccati equations. The program is written so as to handle systems of any order and is restricted only by computer storage size and accuracy. The program has been applied in designing control systems for supersonic inlets. It operates in batch mode and uses five subroutines (ARRAY, SIMQ, FACTR, HSBG, and MINV) from the IBM Scientific Subroutine Package.

LANGUAGE: FORTRAN MACHINE REQUIREMENTS: IBM 7094 PROGRA & SIZE: Approximately 1,798 source statements

PRICE: Frogram \$420.00 Documentation \$18 00

PROGRAM NUMBER: LEW-12505

Magnetir. Jape Library System

The Magnetic Tape Library System is a system of programs used to manage magnetic tape utilization in a computing, facility. The input to the system consists of a tape library master file, a date control card, and transaction cards. The date control card contains the run date as well as fields used in selecting the reports to be printed. The transaction cards contain one of seven codes to designate what action is to be taken with the data on the remainder of the card. Incoming transactions are verified and edited, then processed against the master file. Generated output consists of an updated master file, control reports and a report file. Nine reports are available to the user. The Error Report (R1), the Transaction Report (R2) and the Summary Report (R3) are printed at the time of processing on an on-line printer and are control reports. The remaining six reports, Assigned Tape Listing by Employee (R4), Unassigned tape listing (5), Tape Release Schedule (R6), Tape Release Schedule ** Final Notice ** (R7), Assigned Tape listing by Tape (R8) and the Tape Assigned Summary by Individual (R9) are user reports that are printed off-line by an OS SLAVE print program that is also a part of the system.

LANGUAGE: ANSI COROL MACHINE REQUIREMENTS: IBM 360 PROGRAM SIZE: Approximately 1,800 source statements PRICE: Program \$680.00 Documentation \$8.00 PROGRAM NUMBER: ARC-10942

٦,

-Critical Path Method Computer Program

The Critical Path Method (CPM) program was developed to assist in the planning and management of a project where the interrelationships between activities and functional areas are numerous and involved, or if the responsibilities for various phases are fragmented or widely spread, or if the project is so large or complex it is difficult to visualize as a whole. This program assists in project management by utilizing the systems concept for planning, scheduling, and control of an organization's project objectives and plans. The system is based on the network approach, essentially an advanced concept of the flow diagram, with the network made up of two basic components activities and events. Activities are physical or mental work to be accomplished and make up the project time or life span, and are seen in a network as arrows between events. Events are connection points between activities, marking their beginning and ending. They appear in a network as nodes or junctions at which activity arrows converge or diverge. With the development of the project plan, the network then displays sequential and parallel relationship between items of work by its arrangement of activity arrows

LANGUAGE: FORTRAN V (90°), ASSEMBLER (10%) MACHINE REQUIREMENTS: UNIVAC 1108, Exc. 8 PROGRAM SIZE: Approximately 11,366 source statements PRICE Program: \$1,440.00 Documentation \$69.00 PROGRAM NUMBER: COS-02390

NGPSS—NADC General Purpose Simulation System for CDC 6600 Series Computers

This program package is an adaptation of the IBM General Purpose Simulating System to CDC equipment The simulation system may be used for conducting evaluations and experiments on systems, methods, proc esses, or designs. It can be applied to problems in which transactions, people, or equipment are competing for services of other people or equipment, when it is of interest how well the service organization will respond to demands System testing and time compression is an advantage of simulation systems such as NGPSS. The input parameters to NGPSS are determined from a flow chart of the system being simulated. An output editor allows three output options. Output includes statistics on transactions, as well as plotter produced histograms and graphs. Limitations of the package are few, any system with identifiable entities may be simulated and over two billion characteristics can be assigned to the transactions being modeled. The package represents an entire simulation system for CDC 6000 series machines operating under SCOPE 3.3. The system operates in batch mode from card input

LANGUAGE: COBOL (52's) FORTRAN (31%) COMMPASS (17%)
MACHINE REQUIREMENTS: CDC 6000 Series SCOPE 3:3
PROGRAM SIZE: Approximately 17,552 source statements
DISTRIBUTION MEDIA: 7 Track CDC SCOPE Formatted

Mag. Tape
PRICE: Program \$1,980 Documentation \$11.00
PROGRAM NUMBER: DOD-00037

CANS—Computer Assisted Network Schoduling System

The computer Assisted Network Scheduling System (CANS) was developed and implemented to meet the needs of the Manned Space Flight Network. This system provides efficient, effective management and control of resources in a complex scheduling environment. The system is an automated storage and retrieval management tool. The system stores, in computer files, resources available for schell-ling, accepts and analyzes requests or demands for use of resources; matches resources with demands, and produces conflict free schedules for the time periods specified by the user. Conflict analysis is provided for requested events that cannot be scheduled due to resource conflict. This is a general purpose program that can be adapted to assist management in solving planning, controlling, and conflict free scheduling probtems in a complex resource scheduling environment

LANGUAGE FORTRAN IV, ASSEMBLER
MACHINE REQUIREMENTS IBM 360
PROGRAM SIZE: One 2400 ft imagnetic tape (unloaded data set)
PRICE Program \$1,280.00 Documentation \$13.00
PROGRAM NUMBER: GSC-10909

GREMEX—Goddard Research and Engineering Management Exercise Simulation System

GREMEX is a man machine simulation game of the life of a Research and Development project plan through the

construction phase. The game is computer based to the extent that a computer is used to calculate (simulate) the effects of management actions and contractor performance. GREMEX is not new in that it has previously had wide distribution, but the program and documentation has been revised innumerable times in the past. This report is for the revised version as it exists to date. The basic action of the GREMEX program is to simulate one month of project work for each computer input or play. The project itself is described in terms of a PERT network and is originally established by data cards at the start of the game. The numerical reactions of the model are related to typical R&D projects and the PERT data cards include probabilities of meeting the time, cost and performance goals Provisions for student inputs (decisions) to change these values are provided. The computer program itself must be supported by other paper simulation data such as project plan or contractor evaluation and selection documents. This simulation may be adjusted for the teaching intent or needs of the group in emphasis on the various areas of the project. The general purpose GREMEX program handles a project that consists of one to fifteen contracts. Any sort of system may be represented by the program provided that it consists of a connected sequence of events that can be described in a flow chart. The program will accept any project that consists of less than 1,000 events. A smaller memory computer could be utilized by reducing the number of events and redefining certain dimension statements through the routines. Initially, the players are presented with the project with the understanding that no ground rules exist; however, NASA policy should be their guide. They are permitted to do almost anything and the model will react as it would in real life. To each player or team of players there is assigned a referee-instructor who serves as the interface between the players and the computer program. He converts the players decision to a form that will be acceptable to the model.

LANGUAGE: FORTRAN H (931), ASSEMBLER (74) MACHINE REQUIREMENTS. IBM 360 PROGRAM SIZE: Approximately 5,706 source statements PRICE: Program \$610.00 Documentation \$52.00 PROGRAM NUMBER: GSC-11512

GEMS-Generalized Evaluation Model Simulator

Generalized Evaluation Model Simulator (GEMS) is a stochastic, time event, digital computer program designed to aid the analyst system designs, and in determining the sensitivity of system performance to changes in design parameters. The program simulates, to a high level of detail, the responses of complex systems of equipment and personnel as they are subjected to a time-varying load. A prime application is to situations where a number of "customers" must compete for the services of a system with limited resources of equipment and personnel, where the equipment can fail and personnel can commit errors. and where the correction of these malfunctions is constrained by operations and maintenance policy and procedures. The program consists of over 60 modular routines. Although experience has shown that these subroutines can be readily modified for special application, GEMS has a wide applicability without modification because of the general nature of the responses it simulates, and because the load and system characteris tics are defined by the input data. It is especially useful when the system parameters are either empirically obtained and cannot be readily incorporated in an analytic model, or where they are unknown and "best values" must be established by sensitivity analyses. GEMS deals in

abstract entities known as "customers" and "functions," whose real world definitions are maintained external to the computer; only their pertinent characteristics are entered as input to the simulation. Customers are any entities that arrive at the system input and demand a specified set of equipment or personnel functions to be interconnected into an operational configuration. A customer could be a satellite coming in view of a ground station, a batch of raw data arriving at a central computing facility for processing and reduction, or an individual requesting a communications circuit from an operator.

LANGUAGE: FORTRAN IV (83%); PL/I (14%); ASSEMBLER

MACHINE REQUIREMENTS: IBM 360/95

PROGRAM SIZE. Approximately 3,504 source statements PRICE. Program \$840.00 Documentation \$28.00 PROGRAM NUMBER: GSC-11641

CALICO — Capital Assets Location Inventory Control

The Capital Assets Location Inventory Control (CALICO) system is designed to computerize and maintain a location index for every item which is considered accountable property. To provide this function, a complete list of items is maintained on magnetic tape. This tape (CALICO MASTER) is updated by the program and scanned to obtain several reports to be used by the stock room and management personnel to guarantee current and accurate location information about each item and its history of previous usage. Two property listings are generated showing the most current location index for each item on the CALICO MASTER tape. The Active Property Inventory shows all items which are actively in inventory. The remaining items which have been loaned, or transferred from the property record, or have been temporarily used as equipment for a short term contract, are combined with the active property to form a Total Property Inventory Report. Other reports include Delinquent Reports, Location by Line Reports, and Chronological History Reports.

LANGUAGE COROL
MACHINE REQUIREMENTS: CDC. 3000L Series
PROGRAM SIZE. Approximately 927 source statements
PRICE: Program \$460.00 Documentation \$13.00
PROGRAM NUMBER: GSC-11652

Boeing Computerized Preventative Maintenance Program

From 1965 to 1970 there was no effective system for scheduling and documenting performance by routine preventive maintenance on Boeing assigned Ground Support Equipment Preventive maintenance was being controlled by manually scheduling work orders for release of work and verification of completion of the procedure and on the work order. As preventive maintenance consists of a large number of small repetitive tasks, this control system proved to be cumbersome and did not provide timely reporting for management surveillance. A computerized maintenance program was implemented to take care of the above problem. There are currently 7,000 active maintenance items on file, generating approximately 25,000 task performances per year. Since implementation, the system has proven to be an effective management tool for administering the preventive maintenance program. The Boeing Preventive Maintenance System is a computerized scheduling and reporting system which automatically schedules préventive maintenance activities, records historical data relative to maintenance performance and provides detail scheduling and work load visibility. Automatic scheduling is accomplished as a function of last complete data and prescribed frequency. Since implementation, 100 percent of the hardware has been maintained on schedule. The system can generally be readily adapted to any existing work instruction media without changing format. The weekly management reports give detailed visibility of delinquent maintenance to be performed. 10 weeks in advance.

LANGUAGE: COBOL

MACHINE REQUIREMENTS: Any computer with COBOL Compiler and 200 k bites of storage, 2 tape drives and one disc drive

PROGRAM SIZE: Approximately 4,338 source statements PRICE: Program \$770.00 Documentation \$8.00 PROGRAM NUMBER: KSC-10805

Logistics, Flardware and Services Control System

This computer system permits on site direct control of logistics operations which includes spare parts, initial installation, tool control, and repairable parts status and control, through all facets of operations. The system will integrate all logistics actions and control receipts, issues, loans, repairs, labrications and modifications to effectively predict and allocate logistics parts and services. The user inputs data on paper tape while posting a ledger and maintaining a real-time inventory posting file. Subsequent reports can be batch processed as needed to provide up to 20 different reports. Status of all logistics requirements is posted as needed with all repair, unserviceable transfers, purchases, and shortages displayed on one ledger for complete inventory control. Configuration of parts is further maintained via the use of a provisioning ledger report which shows all next higher assembly application, etc. The system permits a real-time operational mode of logistics issues, receipts, loans, shortages, etc. by making direct inputs into a mini computer, receiving hard copy after edit, and batching data on paper tape for remote butch processing to obtain management and working reports. The large computer costs are minimized without degredation of service and edit checks are performed at three distinct levels of operation (input to mini; card punch and ledger print calculation edit; data element vs. table edit. The advantages are the real time mode of the inventory balance, the generation of an edited message, and the subsequent batch processed reports which integrate the provisioning function, tracking function, and the inventory status into a completely controlled logistics operation linked to the user's (or production division) requirements

LANGUAGE: COBOL
MACHINE REQUIREMENTS: IBM:360/65
PROGRAM SIZE: Approximately 5,168 source statements
PRICE: Program \$770.00 Documentation \$27.00
PROGRAM NUMBER: *SC-10819

LRC NASA PERT III

This program package is an information system designed to provide the information flow necessary for project planning, monitoring, evaluation, and coordination at the management level. The system provides effective project control in the areas of time, cost and manpower; although developed for NASA projects, the design can be modified to cross manufacturing lines. PERT TIME III has incorporated many of the important features of earlier logic flow systems plus many improved and desirable innovations to further assist the user. The system consists of eleven basic processing phases including path location, expected start and completion dates, and the production

abstract entities known as "customers" and "functions," whose real world definitions are maintained external to the computer; only their pertinent characteristics are entered as input to the simulation. Customers are any entities that arrive at the system input and demand a specified set of equipment or personnel functions to be interconnected into an operational configuration. A customer could be a satellite coming in view of a ground station, a batch of raw data arriving at a central computing facility for processing and reduction, or an individual requesting a communications circuit from an operator.

LANGUAGE: FORTRAN IV (83%), PL/1 (14%), ASSEMBLER

MACHINE REQUIREMENTS: IBM 360/95

PROGRAM SIZE: Approximately 3,504 source statements PRICE: Program \$840.00 Documentation \$28.00 PROGRAM NUMBER: GSC-11641

CALICO --- Capital Assets Location Inventory Control

The Capital Assets Location Inventory Control (CALICO) system is designed to computerize and maintain a location index for every item which is considered accountable property. To provide this function, a complete list of items is maintained on magnetic tape. This tape (CALICO MASTER) is updated by the program and scanned to obtain several reports to be used by the stock room and management personnel to guarantee current and accurate location information about each item and its history of previous usage. Two property listings are generated showing the most current location index for each item on the CALICO MASTER tape. The Active Property Inventory shows all items which are actively in inventory. The remaining items which have been loaned, or transferred from the property record, or have been temporarily used as equipment for a short term contract, are combined with the active property to form a Total Property Inventory Report, Other reports include Delinquent Reports, Location by Line Reports, and Chronological History Reports

LANGUAGE: COROL MACHINE REQUIREMENTS: CDC 3000L Series PROGRAM SIZE. Approximately 927 source statements PRICE: Program \$460.00 Documentation \$13.00 PROGRAM NUMBER: GSC-11652

Boeing Computerized Preventative Maintenance Program

From 1965 to 1970 there was no effective system for scheduling and documenting performance by routine preventive maintenance on Boeing assigned Ground Support Equipment Preventive maintenance was being controlled by manually scheduling work orders for release of work and verification of completion of the procedure and on the work order. As preventive maintenance consists of a large number of small repetitive tasks, this control system proved to be cumbersome and did not provide timely reporting for management surveillance. A computerized maintenance program was implemented to take care of the above problem. There are currently 7,000 active maintenance items on file, generating approximately 25,000 task performances per year. Since implementation, the system has proven to be an effective management tool for administering the preventive maintenance pro gram. The Boeing Preventive Maintenance System is a computerized scheduling and reporting system which automatically schedules preventive maintenance activities, records historical data relative to maintenance performance and provides detail scheduling and work load visibility. Automatic scheduling is accomplished as a function of last complete data and prescribed frequency. Since implementation, 100 percent of the hardware has been maintained on schedule. The system can generally be readily adapted to any existing work instruction media without changing format. The weekly management reports give detailed visibility of delinquent maintenance to be performed 10 weeks in advance.

LANGUAGE: COBOL

MACHINE REQUIREMENTS: Any computer with COBOL Compiler and 200 k bites of storage, 2 tape drives and one disc drive.

PROGRAM SIZE: Approximately 4,338 source statements
PRICE: Program \$770.00 Documentation \$8.00
PROGRAM NUMBER: KSC-10805

Logistics, Hardware and Services Control System

This computer system permits on site direct control of logistics operations which includes spare parts, initial installation, tool control, and repairable parts status and control, through all facets of operations. The system will integrate all logistics actions and control receipts, issues, loans, repairs, labrications and modifications to effectively predict and allocate logistics parts and services. The user inputs data on paper tape while posting a ledger and maintaining a real time inventory posting file. Subsequent reports can be batch processed as needed to provide up to 20 different reports. Status of all logistics requirements is posted as needed with all repair, unserviceable transfers, purchases, and shortages displayed on one ledger for complete inventory control. Configuration of parts is further maintained via the use of a provisioning ledger report which shows all next higher assembly application, etc. The system permits a real time operational mode of logistics issues, receipts, loans, shortages, etc. by making direct inputs into a mini-computer, receiving hard copy after edit, and batching data on paper tape for remote batch processing to obtain management and working reports. The large computer costs are minimized without degredation of service and edit checks are performed at three distinct levels of operation (input to mini; card punch and ledger print calculation edit; data element vs. table edit. The advantages are the real-time mode of the inventory balance, the generation of an edited message, and the subsequent batch processed reports which integrate the provisioning function, tracking function, and the inventory status into a completely controlled logistics operation linked to the user's (or production division) requirements.

LANGUAGE: COBOL
MACHINE REQUIREMENTS: IBM 360/65
PROGRAM SIZE Approximately 5.168 source statements
PRICE: Program \$770.00 Documentation \$27.00
PROGRAM NUMBER: *SC-10819

LRC NASA PERT III

This program package is an information system de signed to provide the information flow necessary for project planning, monitoring, evaluation, and coordination at the management level. The system provides effective project control in the areas of time, cost and manpower; although developed for NASA projects, the design can be modified to cross manufacturing lines. PERT TIME III has incorporated many of the important features of earlier logic flow systems plus many improved and desirable innovations to further assist the user. The system consists of eleven basic processing phases including path location, expected start and completion dates, and the production

of milestone and activity reports. The system uses a time oriented network structure. Network capacity is characterized by a minimum field length (core) of 52K; there can be 500 starts for every 1100 activities; one path cannot contain more than 700 branches; and the network cannot have more than 10,000 paths. The network time span is limited to a 30 year period from start date to latest completion date. The program operates in batch, uses the CDC RUN compiler, and has a plotting option using a Calcomp or Varian plotter.

LANGUAGE: FCOTRAN IV.
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 7,979 source statements
PRICE: Program \$820.00 Documentation \$12.50
PROGRAM NUMBER: LAR-11887

LABCON-Laboratory Job Control Program

The LABCON program provides a budget control system in a component test laboratory whose workload is made up from many individual budgetary allocations. A job requiring laboratory effort requires the combined support of several jobs and a common denominator is applied to an incoming job, to which all effort is charged and accounted for. The common denominator is the Laboratory Job Number System and the facilities of the Data Processing Department. A job comes in and is inserted into the computer through a Job Input Data Sheet; it is numbered and a prime unit or group is realized along with the other units who will work on it. Each employee makes out a Weekly Job Card each week. This form has a keypunch format, and contains spaces for the employee's serial number, straight time hours, overtime hours, and Laboratory Unit Code. The computer program will tally all hours worked against this given Job File Number each week and carry these hours over from week-to-week so that, when this job is finally completed, all laboratory effort generated by the request is compiled. The unit code number serves as a function and/or equipment utilization code. This code will provide, through selected sort and list operations. valuable information required for proposals and equipment justifications, based upon the amount of loading on a particular facility, system or function.

LANGUAGE: PLI
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 319 source statements
PRICE: Program \$350 00 Documentation \$14.50
PROGRAM NUMBER: MFS-18141

Network Path Program

Network Path is a FORTRAN IV computer program to determine the Nth best minimum or maximum paths in a network. The program was developed from a paper by W. Hoffman and R. Pavley, A Method for the Solution of the Nth Best Path Problem. The minimum free concept as developed by E.F. Moore and G. B. Dantzig is employed to compute the best path. The minimum tree is then superimposed upon the network to determine the Nth best path, using a theorem. Any path P from O to D, which is not minimal, is a deviation from a path Q from 0 to D, such that V(Q)=V(P). If P is minimal, there either P is unique or P is a deviation from another minimal path. The method relative to computer application considers first finding all the paths of minimal value, i.e., 0 is computed. Next is a calculation of all deviations from the paths in 0 and

arranging them in numerical order according to the path value which allows determination of θ . All deviations from paths in θ are then computed, ordered, and merged with non-minimal deviations from paths in θ , thus determining θ , etc. Only the Nth best path values are stored at any stage of the computation; therefore, for large networks, the required storage is essentially that which is needed to store the network. This program is written to handle up to 500 nodes, and the branch links cannot exceed 5.000

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 521 source statements
PRICE: Program \$230 00 Documentation \$5 00
PROGRAM NUMBER: MFS-18691

Special Program for Discounted Cash Flow/Rate of Return Evaluations

This is a set of three programs that is designed to aid the industrial engineer of businessman with an economically sound system for making investment decisions. They are written for any time-sharing remote computer terminal system compatible with BASIC language. The main program is Discounted Cash Flow/Rate of Return Evaluations (DCFROR). This program features a running option for a complete detailed printout of all period cash flows, both net cash flow and discounted cash flow, or final answers only. The program also provides for choices of input and output for cash flows based on annual, semiannual, quarterly, bi-monthly, or monthly periods, with answers converted to an annual basis if other than annual periods are used for higher accuracy of results. The DCFROR program has served to eliminate the lengthy, time consuming and error prone manual solutions for the payout and DCF/ROR percentage results and has upgraded the economic soundness of evaluations by permitting the use of monthly, bi monthly, quarterly or semi-annual net cash flow periods in addition to the conventional annual periods, plus further providing a continuous rate of return percent in addition to the conventional period rate of return percent. INTFAC is a computer program used to provide calculated data for various interest finter considerations such as compound amount data, press of worth data for any specified initial amount, interest rate and quantity of years. The program will further provide the requested information as a table of dollars, as a table of percentages, or as a table of factors Atthough this program is principally used for component calculations in discounted cash flow/rate of return economic evaluations, it will provide interest data for any desired purpose. DEPREC calculates the year beginning book value, annual depreciation amount, and cumulative depeciation through the year ending, for any of the following methods: (1) Two Hundred Percent (200%) or Double Declining Balance. (2) One Hundred Fifty Percent (150%) Declining Balance. (3) Sum of Digits or Sum or Year's Digits. Program output is a table of dollars, a table of factors, or a table of percentages. Another feature of the program is that it has amounts for annual, quarterly and monthly periods. If only an annual printout is required, the quarterly and monthly periods are excluded, resulting in faster output

LANGUAGE: BASIC
MACHINE REQUIREMENTS: GE 420 REMOTE TERMINAL
PROGRAM SIZE Approximately 657 source statements
PRICE: Program \$290.00 Documentation \$22.00
PROGRAM NUMBER: MFS-19040

MIS-Manpower Management Information System

The ultimate objective in the design of this system of programs was to provide the capability of building and maintaining a data bank that integrates all parameters of manpower administration. The system is designed to provide management and division directorate levels with detail information at the program / system level. In addition to processing planning data the system also integrates actual performance data (by month and to date) in order to provide management with regular evaluation reports and to provide a source of data for special management exercises on manpower. The system has been designed to satisfy the following criteria: (1) Dynamic Analysis-Emphasis is on an integrated management intelligence system (2) Control Reports-These inform top management of functional operating performance as compared to predetermined plans (3) Operating Reports-These inform functional management of the current performance of operations. They are a comparative analysis of current operations and operations of previous periods, as well as current performance compared to predetermined plans for the immediate period (4) Planning Reports-These show the various aspects of the structure of the limited manpower resource and provide a basis for alternate courses of management action (5) Exception Reporting-The exception reporting principle has been employed as a guide to management in isolating problems or out of line areas. This is done by flagging excessive variances on monthly variance reports with an asterisk and then using them in the computer logic to generate selected charts for the specific division or office when the number of flagged variances is excessive. Exception reporting improves the information content and applicability of report data

LANGUAGE COBOL MACHINE REQUIREMENTS UNIVAC 1108, SC 4020 Plot for

PROGRAM SIZE: Approximately 12:619 source statements PRICE Program \$1,200.00 Pocumentation \$19.00 PROGRAM NUMBER: EFS-21477

Vehicle and Equipment Operations Management Program

This is a system of programs developed to support the Transportation Division of the Technical Services Office at Marshall Space Flight Center by providing management reports, statistical data and preventive maintenance scheduling on wheeled vehicles and engineering types of equipment. The programs have the following functions (1) They assist the Transportation Division in the Evalua tion of General Support Contractors (2) Assist inforecast ing budget and manpower requirements for all types of vehicles and equipment, (3) Furnish statistics for the users of the vehicle and equipment, including mileage, cost, and depreciation of equipment, and (4) Provides a smooth inspection workflow to the transportation division maintenance shops. The system generates notifications of all major and minor maintenance inspection requirements of all vehicle and equipment based upon gallons of fuel consumed, and for the months elapsed since the mainte nance was issued

LANGUAGE COBOL
MACHINE REQUIREMENTS UNIVAC 1108, EXEC 8
PROGRAM SIZE Approximately 10.898 source statements
PRICE Program \$500.00 Excumentation \$24.00
PROGRAM NUMBER: MFS-21478

Job Resource Optimiz onitor for Project Management System (PMS) Property

The program for Job Resource Optimization to monitor the PMS (Project Management System) Pert and Resource Allocation Program (RAP) routines consists of two routines. The first routine, (Resource Utilization Monitor) RUM, is used to analyze the cutput of PMS and adjust the resource levels of the input to PMS to increase the utilization percentage of each resource. The second routine is a control routine, DRIVER, to execute the PMS and RUM routines in a sequential process over and over until RUM returns a code to signal completion of the optimization process. The PMS program was used for the base for building the optimization process since PMS handles the job resource Pert network data already and outputs the results in a readily accessible format for the optimization process. The optimization process to increase the utilization percentage is simply a method of automatically and systematically reducing the resources available until either the schedule is exceeded or a resource is limited by the quantity needed for the largest single job. Cost is also a consideration for a minimum because even though the resource levels are being reduced, the total job is being lengthened resulting in people required for a longer time period. Minimizing total project cost is therefore the key overall criteria in selecting the best allocation plan from a series of iterations involving many different combinations of manning levels and schedules within the same overall project start and end dates. The second routine (DRIVER) is an assembler program and is not a part of this program package, but a listing of the routine is included in the documentation

LANGUAGE: PL1
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE Approximately 406 source statements
PRICE Program \$250.00 Documentation \$11.00
PROGRAM NUMBER: MFS-21669

Job Resource Allocation, GPSS Model

This program was developed to allocate resources (manpower, equipment, facilities, etc.) for a large number of jobs or tasks based on job priority and resource availability and relating a workable model to conventional computer programs for solving complex management tasks indicates new directions for computer application The program develops a model that takes a job (GPSS transactions) and allocates resources (GPSS storages) based on priority as a job becomes eligible after initial tasks are completed. Jobs are performed when all of the required resources are available. Resources are set initially for each run depending upon the overall job requirements. If the resources are not available, the job must wait or pre-empt if possible, a job of lower priority. The meeting of a milestone is thus dependent directly on the required resources available at the time needed. The model essentially eliminates hand manipulation time to schedule jobs based on available resources.

LANGUAGE: GPSS
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE Approximately 526 source statements
PRICE: Program \$200.00 Documentation \$5.00
PROGRAM NUMBER: MFS-21670

MARVES - Marshall Vehicle Engineering Simulation System

The MARVES system is a computer language developed to aid in the solution of problems related to dynamic

systems that can be described by a system of ordinary differential equations. The MARVES system contains a collection of models which represents the problems to be solved and a description of one or more events peculiar to the problem. The simulation of dynamic systems on a computer requires a numerical method of integrating differential equations and a method of interrupting the integration to introduce discrete changes in the mathematical model. These requirements have led to the development of six basic processes. (1) The initialization process consists of reading input data, computing certain parameters which remain constant thereafter, such as starting conditions for the integration process, and setting certain logical constants. (2) The evaluations of the differential equations. (3) The numerical integration process consists of providing a numerical procedure whereby the differential equations may be evaluated stepwise until stopping conditions have been reached. (4) The interrupt process consists of providing a method of interrupting the integration procedure when certain conditions are satisfied, or changes in dynamics are to be made. (5) The end of step process consists of evaluating variables at the end of each integration step. (6) The termination process consists of satisfying given stopping conditions making needer terminal computations. The primary function of the MARVES language is to provide source statements which specify operations that tailor the program to suit a particular application. These statements furnish a short hand notation for (1) specifying the method of numerical integration, (2) the conditions under which the numerical integration is to be interrupted for special event computation, and (3) input/output statements that are easy to code and debug. The MARVES processor program accepts MARVES statements, converts them to Fortran code, and then executes the Fortran program in the same manner as any other Fortran program.

LANGUAGE: ASA Fortran
MACHINE REQUIREMENTS: IBM 360, IBM 7094, UNIVAC
1108, EMR 6050 and Raytheon 520
PROGRAM SIZE: Approximately 5.200 source statements
PRICE: Program \$990.00 Documentation \$17.00
PROGRAM NUMBER: MFS-21701

FAA Balanced Field Longth, Critical Engine Failure Speed, and Landing Distance Computer Programs

This program was developed to evaluate the ability of a multiengine aircraft to survive an engine failure during takeoff. If an engine should fail, a decision must be made to shutdown and stop reaching the end of the runway or to continue takeoff with reduced power. The parameters necessary for making this decision are, (1) the Critical Engine Failure Speed or the velocity achieved during takeoff roll at which the distance necessary to continue takeoff with one engine inoperative equals the distance needed to shut down all engines, apply brakes, and stop, and (2) FAA Balanced Field Distance or the runway length nu Med to accelerate with all engines to the critical engine failure speed, then continue takeoff and clear a 35 foot obstacle at the end of the runway with one engine out, or refuse takeoff and stop. By using the takeoff characteristics of a specific plane, this program can calculate these parameters.

LANGUAGE: BASIC MACHINE REQUIREMENTS: SIGMA 7 PROGRAM SIZE: Not Applicable PRICE: \$25.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. FROGRAM NUMBER: MFS-21873

MARSYAS - Marshull System for Aerospace Simulation

MARSYAS (Marshall System for Aerospace Simulation) was developed by NASA's Computation Laboratory at Marshall Space Flight Center to furnish engineers with a software system that allows quick and easy simulation of physical systems on a digital computer. MARSYAS is a simple, flexible language which can be coded by users who are unfamiliar with computer programming. It is designed for the engineer with little experience in simulation who desires to simulate large physical systems. The language can be used to solve a system of differential equations or to simulate control systems including analog computer block diagrams or both simultaneously. Thus, the user has the ability to mix differential equations with diagrams in his model. The block diagrams can contain, among other things, adders, integrators, transfer functions, multiple input/output nonlinear devices, algebraic equations and nonlinear ordinary differential equations. A block diagram is specified by the user-given names of its models and submodels, inputs and outputs, element names, parameters (if any), and their inter-connections. Submodels can be nested to any degree required. With MARSYAS, no present pattern of connecting elements is required. Elements can be connected in pairs, groups or any manner desired by the user. A large library of Standard Elements and Excitation Functions is part of the MARSYAS system. DEVICE and FUNCTION statement operators allow the user to construct unusual element excitation functions as needed. MARSYAS is a flexible language in that, with few exceptions, there is no rigid statement operator structure within a given module. Most statements can be used without regard for the order in which MARSYAS is installed, the user has the capability of storing models in a Functional Data Base. The Fortran Object Program generateu from the MARSYAS source program can be extracted and run separately, if the user's computing facility can accomodate this feature. When using CHANGE operators, the user has multiple simulation capability without the necessity of either rewriting his model of resubmitting his deck. An elaborate plotting system is part of the MARSYAS language allowing the user nearly unlimited flexibility in specifying his graphical output. Additionally, the Fast Fourier Transform of any output variable can easily be obtained. A tabular listing of a model in the Functional Data Sase or of a model currently being run can be obtained using the LIST operator. Automatic features of MARSYAS include the detection and solution of linear and nonlinear algebraic loops. For problems which contain discontinuities, the MARSYAS system automatically changes integration schemes to integrate through the discontinuity. MARSYAS is designed in modular form so that modifications to the systems models can be made with a minimum effort. In order to achieve comprehensive analysis capability and effective computation, modern control theory is used as the mathematical foundation of MARSYAS. The differential equations generated from block diagrams, or coded as equations, are rearranged internally into vector-matrix state equations which are then solved. The language is designed so that the user transmits to the computer only the information essential to describe the mathematical model and specify the simulation run. MARSYAS is divided into four successive modules which describe independent functions of the simulation.

These modules are as follows: (1) Description Module, (2) Modification Module (optional), (3) Simulation Module, (4) Post Processing Module. The user has the ability to control some of the internal processing of the simulation by specifying his numerical integration method, integration step size or even the truncation error. Normally, he need not concern himself with 1.25e details since MARSYAS handles these details automatically, MARSYAS names can be up to 36 characters in length so that the same names as found in engineering documentation can be used. The MARSYAS alphabet consists of the letters A turough Z, the numbers O through 9, and the backward slash (7). There are no reserved words in MARSYAS.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 15,000 source statements
PRICE: Program \$1,240.00 Documentation \$22.00
PROGRAM NUMBER: MFS-22672

A Computerized Solution of the Kepner-Tregoe Method Algorithm

This package is a set of procedures designed to perform a computerized solution of the Kepner-Tregoe Method. (The Rational Manager, A Systematic Approach to Problem Solving and Decision Making, C.H. Kepner and B.B. Tregoe, McGraw-Hill Book Company, Incorporated, 1965.) of selecting the optimal solution from a set of alternatives which satisfy an imposed set of objectives or constraints.

LANGUAGE: APL (A Programming Language)
MACHINE REQUIREMENTS: IBM Model 2741 or 1050
terminal and TSO System
PROGRAM SIZE: Not Applicable

PRICE: \$95.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-22997

RETANN - MSFC Estimated Retirement Annuity Calculation Program

This program provides retirement annuity reports which outline the retirement benefits available to eligible employees and their survivors according to length of service, age, deposits, proposed separation date, and the current cost of living percentage with reductions to provide survivor annuity to widow or widower and health benefits premium. Necessary input parameters are the length of service, age, proposed separation date, deposits, and the current cost of living percentage.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC 1100 SERIES
PROGRAM SIZE: Approximately 667 source statements
PRICE: Program \$90.00
PROGRAM NUMBER: MFS-23073

Engineering Critical Components Listing

This program was designed to maintain an inventory of specifications and part numbers for engineer components. This inventory listing can be automatically updated with change cards and printed in a variety of optional lists.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS CDC-924
PROGRAM SIZE: Approximately 354 source statements
PRICE: Program \$340.00 Documentation \$2.50
PROGRAM NUMBER: MFS-24321

Plant Services Recall System

This system will provide an automated procedure for issuing Service Notices and will maintain a current file or proofload test due dates, preventive maintenance (P.M.) due dates, and dynamic averages of hours/task work assignments. It issues monthly, quarterly, semi-annual, and annual summaries of equipment service requirement schedules and loading. The purpose of this system is to develop a system of programs to detect and capture all due dates and automatically issue Recall System Notices for proofloading and/or preventive maintenance on fixed or movable equipment and to maintain an average of hours per task performance. This dynamic average is to be used as an estimate for schedule loading. This system will assure timely notification to both the Using Department and Plant Services of due dates for proofload testing and P.M. The system will not depend upon the user to become aware of the due date, but will provide Automatic Notice to the using department heads. This program should facilitate the scheduling of proofload testing and preventive maintenance to maximize usage of manpower and should conform to contractual obligations for any large industry requiring a regular preventive maintenance program

LANGUAGE: COBOL
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 8.084 source statements
PRICE: Program \$500.00 Documentation \$15.50
PROGRAM NUMBER: MSC-17122

Failure Mode and Effects Analysis Program (FMEA)

The Failure Mode and Effect Analysis program is a tool to be utilized with a failure point summary dictionary and standard storage and retrieval routines for the purpose of maintaining a data file of reliability analyses of various designs. The primary purpose of this program is to assist in the identification and correction of failures associated with critical effects prior to design release. This program was developed for the space shuttle contract but is general enough to be adapted to any aerospace or commercial reliability activities.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE Approximately 137 source statements
PRICE: Program \$430 00 Documentation \$7.50
PROGRAM NUMBER: MSC-17446

Record of Task Progress

This program is a supervisory tool for manipulating task descriptions and milestones and printing them in several formats to give management a high degree of visibility and control of a large number of assigned tasks and milestones. The inputs to the program are task descriptions, milestones descriptions and due dates identified by project and responsible subordinate, and a description of the changes for which the program is being re run. The output consists of: (1) a complete list if task descriptions. (2) a complete list of milestones, (3) a combined lists of tasks, and milestones for each subroutine, and (4) a "Change Block," similar to those on engineering drawings, giving a chronological tabulation of the changes made each time the program was submitted.

LANGUAGE FORTRAN IV (57). ASSEMBLER (43). MACHINE REQUIREMENTS IBM 360 PROGRAM SIZE Approximately 882 source statements PRICE: Program \$250.00 Documentation \$10.50 PROGRAM NUMBER: MSC-17451

Cost Information Management Computer Program

CIM is a computer program designed to facilitate calculation and reporting of costs for programs organized to a Work Breakdown Structure. The model is general since the actual computing algorithm and all auxiliary information are inputs. In addition, the model is designed to handle multiple cases. After the program calculates the cost for the lowest level items for each cost category, it sums the cost categories and sums to higher levels automatically. Another added feature to the model is the ability for the user to "group" items in sets rather than the WBS hierarchical scheme.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 852 source statements
PRICE: Program \$250.00
PROGRAM NUMBER: MSC-17556

Logistics Resupply Computer Program

This program implements a logistics analysis in a computer program and provides a means for processing a variety of experiment scheduling and cargo resupply requirements. The processed data is presented as the summation of common cargo types for a period of ten years at monthly intervals, and are documented in tabular listings and CRT displays. This program provides a means of handling a complex array of logistics items and scheduling alternatives, it may be adaptable to military areas wherein logistics requirements are significant. Industries that involve large quantities of logistics materials may also avail themselves of this program.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 556 source statements
PRICE: Program \$350 00 Documentation \$2.50
PROGRAM NUMBER: MSC-19116

Manpower Accounting Program

This program provides the user with several different tables on which he can base his manpower use cost. The informatic., given by these tables is as follows: (1) Provides summaries for weekly and monthly activity reports; (2) Keeps track of the expenditure of contractor hours and dollars with estimates of depletion so that procurement can be initiated in sufficient time to avoid interruption in contractor services; (3) Prepares summaries of which charge numbers are being used and at what rate; and (4) Provides data which can be presented to management for annual reviews or when there is some question about a particular phase of the employees use. Some of the tables are very detailed and some are merely summaries suitable for reports. The program recognizes several different breakdowns of personnel types and task categories and prepares separate tables for earn of them. There are twelve different tables given in the output: (1) Personnel Tasks and Hours: (2) Current Tasks; (3) Detailed Activity Report: (4) Summary of Hours by Section and Task Catgeory: (5) Summary of Hours by Task Duration and Task Type; (6) Summary of Hours by Type of People; (7) Contractor Hours Expended: (8) Contractor Dollars Expended, (9) Tasks Completed; (10) Summary of Hours by Project; (11) Summary of Hours by Charge Number: and (12) Missing Task Cards.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360/65 or any machine

that has a compatible FORTRAN IV compiler PROGRAM SIZE: Approximately 525 source statements PRICE: Program \$160.00 Documentation \$9.00 PROGRAM NUMBER: NPO-11973

Morgantown Mass Transit Simulation Medel

The Morgantown Transit System simulation model is a tool for studying the effects of various system designs and operating policies on the performance of the system. The model uses the viewpoint that the world is composed of entities and their attributes, various ordered sets of entities (such as vehicle queues), and events to describe the system and its operation. The flow of the model is as follows: Passengers arrive stochastically and are gathered into loads according to their common destinations. An attempt is made to assign a vehicle to each lead. If successful, departure is scheduled by the dispatch algorithm. Otherwise, a vehicle departs, its arrival is scheduled at the destination station. After arrival, it unloads and the vehicle is available for reassignment. The guideway configuration linking the stations is specified by input, and can be as exact as available data permits. Station configuration, on the other hand, is an approximation, but the discrepancies are minor. There are extensive provisions for convenient interactive user control of the model, allowing for a variety of output reports. This program will run only on the National CSS timesharing system (NCSS).

LANGUAGE: SIMSCRIPT II
MACHINE REQUIREMENTS: NCSS System
PROGRAM SIZE: Approximately 2.200 source statements
PRICE: Program \$560.00 Documentation \$10.50
PROGRAM NUMBER: NPO-13522

Minority Business Capabilities File

This program is a management information system designed to generate reports on selected minority businesses. The program provides a file on business capabilities that permits ready identification of sources of specific or particular requirements. The program is extremely flexible in that the number of organizations and available capabilities in the file is limited only by the number of digits in the data control numbers assigned to the organizations and item descriptions or capabilities. The program provides for the selection of organizations by physical location or grouping of locations. On the other hand, organizations can be selected by the sphere of interest of their particular capabilities; i.e., local, regional, or national. Maximum versatility of terminology describing available capabilities is achieved by the permuted item description index. Keypunched data is input to the program to create or update a master file, the input is edited and error messages are printed. The output reports include: (1) Business Capabilities Register; (2) Business Capabilities Index: (3) Capabilities Index Headings and Particular Interests; (4) Item Description Cross-Reference; (5) Batch List and Error Report. The program operates in batch mode.

LANGUAGE: COBOL MACHINE REQUIREMENTS: IBM OS 360/370 PROGRAM SIZE: Approximately 3,337 source statements. PRICE: Program \$610.00 Documentation \$15.00 PROGRAM NUMBER: NPO-13834

TIMER - A Tree-Like Task and Time Record System

TIMER provides a uniform system of reporting and displaying time charges for all task groups within a

multitude of work assignments. The system reports any combinations desired. It is flexible enough to make reportings as desired. Each week, each employee submits a Weekly Time Charge Sheet on which he has recorded the hours spent on each project, task, and subtask he worked on. The TIMER program then accumulates the time charges on a monthly basis and year to date. The accumulative man-months are printed for any combination of the item, department, employee class, project, task, and subtask. The main features of the program are: (1) a tree-like structure of tasks, (2) preassignment of tasks, (3) task definitions at any level of responsibility, (4) tasks

defined at a lower or higher level of responsibility, which are under the same line of responsibility, are mutually inclusive, and (5) tasks defined at the same level of responsibility, are mutually exclusive. TIMER can be applied to almost any tree-structured system, such as parts lists and organization charts.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 837 source statements
PRICE: Program \$340.00 Documentation \$8.00
PROGRAM NUMBER: NUC-10213

FLUID MECHANICS

Includes boundary layer flow; compressible flow; gas dynamics; hydrodynamics and turbulence.

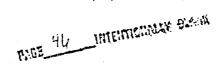
MULTIWICK: A Computer Program that Numerically Integrates the Differential Equations that Describe the Hydrodynamics of a Large Class of Heat Pipes

MULTIWICK is a computer program to numerically integrate differential equations that describe the hydrodynamics of high performance heat pipes that have muliple flow paths for condensate to return to the evaporator regions. The program MULTIWICK is applicable to the following types of flow paths: (1) Wick - a single piece of porous material that runs the length of the heat pipe. It is usually either a layer that lines the inner wall of the heat pipe or a diametral slab. (2) Arteries - porous walled conduits that run the length of the heat pipe and are closed at the evaporator end. Primed arteries provide low flow resistance and a high capillary pressure. (3) Excess-Liquid Reservoirs - axial channels that primarily provide excess-liquid control in zero-gravity operation (excess liquid resides in the reservoirs rather than in a vapor space slug). An excess-liquid reservoir can be either a porouswalled open ended tube, or a channel formed by a tube in close proximity to the intersection of a wick and the heat pipe wall. Unlike arteries, reservoirs usually do not remain filled their entire length. (4) Fillets - liquid that forms in corners due to surface tension. The fillet size at a given point along its length is automatically set by the vaporliquid pressure difference at that point, (5) Bilge - liquid that lies in the bottom of a heat pipe operating in a gravitational field. (5) Circumferential Grooves - distribute liquid under the action of surface tension across the inner surface of the heat-pipe wall. (7) Vapor Spaces - provide flow paths for vapor to return to the condenser sections. MULTIWICK has five operational modes that provide the user flexibility in answering crucial heat-pipe design questions. In the preliminary analysis of a new heat pipe, the designer uses one operational mode (Mode No. 1) to find the optimum amount of working fluid and the corresponding maximum heat-transfer rate for a specific condition. (The optimum amount of working fluid is defined as that amount that provides the greatest heattransfer rate without resulting in a liquid slug in a vapor space). Once the amount of working fluid has been determined, the user can then find the maximum heattransfer rate at any other operating condition for that amount of fluid (Mode No. 4) In Mode No. 2, the user specifies both the amount of working fluid and a heattransfer rate. MULTIWICK then calculates the liquid distribution and the variation of the vapor-liquid pressure difference in the heat pipe. Such a calculation is useful, for example, to find the length of liquid slugs in vapor spaces that can result from liquid expansion at higher operating temperatures. In the case of an arterial heat pipe. MULTIWICK has two additional operational modes that calculate the maximum heat-transfer rate under which arteries will prime. One is for an optimum amount of fluid for priming (Mode No. 3); the other is for a specified amount (Mode No. 5). The MULTIWICK user specifies the heat input and rejection distribution. The heat pipe is divided into sections and the fraction of the total heat throughout is specified for each section, then the program is not limited to heat pipes with only one evaporator, one adiabetic and one condenser section. The MULTIWICK program incorporates a mathematical model of flow through fibrous wicks that includes the effect of: (1) Meniscus recession - the reduction of the flow area with increasing vapor-liquid pressure difference due to the meniscr at the wick's surface attaining a higher curvature. (2) Partial saturation - the emptying of the progressively smaller pores of the wick as the vapor liquid pressure difference approaches the critical value where the wick fails (3) Hysteresis - the relationship between the level of saturation of the wick and the vapor-liquid plessure difference depends on whether the pressure difference has been increasing or decreasing. The MULTIWICK user. therefore, specifies whether the heat pipe starts from a state where the wick is initially saturated or, as in the case after a burnout, from a state where the wick in the evaporator region has dried out. The user may also elect a simple model of fully saturated wick operation that does not include the above effects.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM S'ZE: Approximately 2.331 source statements
PRICE: Program \$710 00 Documentation \$12.50
PROGRAM NUMBER: GSC-12009

Compressible Laminar or Turbulent Nonsimilar Boundary Layers Computer Program

This computer program was developed to solve the compressible nonsimilar-boundary layer—equations—for continuity, mean momentum and total mean enthalpy for an ideal gas with constant specific heat. An implicit finite-difference procedure is used. The program will solve problems with the following configurations: (1) two-dimensional, (2) anisymmetric where the boundary-layer thickness is much less than the body radius, and (3) swept infinite cylinders. The eddy viscrisity is taken as a function of the local boundary layer thickness, the normal distance from the wall, and the mean velocity gradient in the boundary layer. The turbulent Prandti



number may be either a constant or a specified tabulated function of the ratio of the normal distance from the wall to the boundary-layer thickness. By setting the eddy viscosity equal to Zero, nonsimilar-laminar-boundary layer flows may be computed. Since a finite-difference procedure is used, the effects of variable wall and edge boundary conditions and wall blowing or suction are easily included by modifying the program inputs.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1.028 source statements
PRICE: Program \$440.00 Documentation \$11.00
PROGRAM NUMBER: LAR-10990

Program to Determine Radiating, Nonadiabatic, Inviscid Flow Over A Blunt Body by the Method of Integral Relations

This computer program was developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, temperature, density, velocity, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations. The program calculates the radiating nonadiabatic flow of air in chemical equilibrium. Results obtained agree with results from inverse and time-dependent techniques. The agreement indicates that this method of solution provides an accurate description of the blunt-body flow field in the subsonic region. The equations which govern inviscid, radiating, nonadiabatic steady flow of equilibrium air over a blunt body traveling at hypersonic speeds are a system of nonlinear partial differential equations derived from the laws of conservation of mass, momentum and energy. The modified method of integral relations is used to transform the governing equations into a set of ordinary differential equations that are numerically integrated to yield the details of the thermodynamic and flow properties within the shock layer. Provisions have been made in the governing equations for coupled radiating flow-field analysis. The governing differential equations are solved by a fourth-order Runge-Kutta integration technique to give shock-layer thickness, shock angle, and the fluxes of mass, momentum, and energy at the body surface. The documentation contains a description of the computer program along with the methods used in the digital approximations, flow charts, instructions for the user, and a test case with input and output listings.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 3.188 source statements
PRICE: Program \$790.00 Documentation \$14.00
PROGRAM NUMBER: LAR-11048

Numerical Solution of the Unsteady Navier-Stokes Equations

A computer program has been developed to solve the unsteady, two-dimensional, incompressible Navier-Stokes equations. The numerical method makes use of an iterative solution of a Poisson's equation for pressure followed by an explicit calculation of velocities. Unsteady flow in a two-dimensional, rectangular cavity with the upper wall moving at constant velocity is investigated using the computer program. The calculations start with the fluid at rest in the cavity and continues until no further change occurs in the velocity. Results are given for cavities with aspect ratios of 100. Results are also given for several Reynolds number of 100. Results are also given for several Reynolds numbers between 100 and 500 for a square cavity. Calculated velocities from the unsteady Navier-Stokes equations at

large times are compared where possible to velocities calculated from the steady Navier-Stokes equations and to the results of steady experiments; good agreement is presented in the docur ientation. A technique for conducting a numerical flow visualization experiment in conjunction with the solution of the Navier-Stokes equations is described. The results of the experiment are recorded on film which may be shown on a projector.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 611 source statements
PRICE: Program \$350.00
PROGRAM NUMBER: LEW-11415

CFNA - Compressible Flow Network Analysis Computer Program

A computer program, CFNA, has been developed which solves the problem of an arbitrarily connected one dimensional compressible flow network with pumping in the channels and momentum balancing at flow junctions. The program has been specifically designed to include pressure drop calculations for impingement flow and flow through pin fin arrangement, as currently found in many air cooled turbine bucket and vane cooling configurations. The calculation part of the program consists of two major subdivisions. The first section computes the compressible pressure drop through a single passage including friction. orifice, and pumping losses. Provision is made for inlet losses, variable geometry, and pin fin arrays. The second part of the program balances flows and press is throughout the network. This is an iterative procedure involving Matrix evaluations. It converges rapidly in most instances. The program alternates between these two sections on a minimum of three times, and reaches a required tolerance on percentage change of total flow befo a outputing results.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2.898 source statements
PRICE: Program \$590.00 Documentation \$13.50
F. OGRAM NUMBER: LEW-11859

Co:..puter Program for Quasi-One-Dimensional Compressible Flow With Area Change and Friction for Application to Gas Film Seals

A computer program, AREAX, has been developed which calculates the properties of compressible fluid flow with friction and area change. The program carries out a quasione-dimensional flow analysis which is valid for laminar and turbulent flows under both subsonic and choked flow conditions. The program was written to be applied to gas film seals. This computer program enables the prediction of gas-film-face-seal performance when face deformation and/or radial area change is significant. The analysis is especially useful for choked flow conditions. The program must be supplied with the geometry of the seal, the gas properties, the reservoir conditions, the constants for determining the variation of mean friction factor with Reynolds number, and certain logical variables which control output. In general, AREAX performs the following operations in analyzing the flow across a seal; it reads the input data and checks that these data are consistent. When the input have been read. AREAX analyzes the flow for each combination of film thickness and tilt angle. The program first solves the Mach number equation and determines the Mach number distribution across the seal number may be either a constant or a specified tabulated function of the ratio of the normal distance from the wall to the boundary-layer thickness. By setting the eddy viscosity equal to Zero, nonsimilar-laminar-boundary layer flows may be computed. Since a finite-difference procedure is used, the effects of variable wall and edge boundary conditions and wall blowing or suction are easily included by modifying the program inputs.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: CDC-6000 Series

PROGRAM SIZE: Approximately 1,028 source statements PRICE: Program \$440.00 Documentation \$11.00 PROGRAM NUMBER: LAR-10990

Program to Determine Radiating, Nonadiabatic, Inviscid Flow Over A Blunt Body by the Method of Integral Relations

This computer program was developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, temperature, density, velocity, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations. The program calculates the radiating nonadiabatic flow of air in chemical equilibrium. Results obtained agree with results from inverse and time-dependent techniques. The agreement indicates that this method of solution provides an accurate description of the blunt-body flow field in the subsonic region. The equations which govern inviscid, radiating, nonadiabatic steady flow of equilibrium air over a b'unt body traveling at hypersonic speeds are a system of nonlinear partial differential equations derived from the laws of conservation of mass, momentum and energy. The modified method of integral relations is used to transform the governing equations into a set of ordinary differential equations that are numerically integrated to yield the details of the thermodynamic and flow properties within the shock layer. Provisions have been made in the governing equations for coupled radiating flow-field analysis. The governing differential equations are solved by a fourth-order Runge-Kutta integration technique to give shock-layer thickness, shock angle, and the fluxes of mass, momentum, and energy at the body surface. The documentation contains a description of the computer program along with the methods used in the digital approximations, flow charts, instructions for the user, and a test case with input and output listings.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 3,188 source statements
PRICE: Program \$790.00 Documentation \$14.00
PROGRAM NUMBER: LAR-11048

Numerical Solution of the Unsteady Navier-Stokes Equations

A computer program has been developed to solve the unsteady, two-dimensional, incompressible Navier-Stokes equations. The numerical method makes use of an iterative solution of a Poisson's equation for pressure followed by an explicit calculation of velocities. Unsteady flow in a two-dimensional, rectangular cavity with the upper wall moving at constant velocity is investigated using the computer program. The calculations start with the fluid at rest in the cavity and continues until no further change occurs in the velocity. Results are given for cavities with aspect ratios of $\frac{1}{2}$, $\frac{1}{2}$, and $\frac{1}{2}$ with a Reynolds number of 100. Results are also given for several Reynolds numbers between 100 and 500 for a square cavity. Calculated velocities from the unsteady Navier-Stokes equations at

large times are compared where possible to velocities calculated from the steady Navier-Stokes equations and to the results of steady experiments; good agreement is presented in the docur-ientation. A technique for conducting a numerical flow visualization experiment in conjunction with the solution of the Navier-Stokes equations is described. The results of the experiment are recorded on film which may be shown on a projector.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 611 source statements
PRICE: Program \$350 00
PROGRAM NUMBER: LEW-11415

CFNA - Compressible Flow Network Analysis Computer Program

A computer program, CFNA, has been developed which solves the problem of an arbitrarily connected one dimensional compressible flow network with pumping in the channels and momentum balancing at flow junctions. The program has been specifically designed to include pressure drop calculations for impingement flow and flow through pire fin arrangement, as currently found in many air cooled turbine bucket and vane cooling configurations. The calculation part of the program consists of two major subdivisions. The first section computes the compressible pressure drop through a single passage including friction, orifice, and pumping losses. Provision is made for inlet losses, variable geometry, and pin fin arrays. The second part of the program balances flows and press is throughout the network. This is an iterative procedure involving Matrix evaluations. It converges rapidly in most instances. The program alternates between these two sections on a minimum of three times, and reaches a required tolerance on percentage change of total flow befo a outputing results.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,898 source statements
PRICE: Program \$590.00 Documentation \$13.50
r.OGRAM NUMBER: LEW-11859

Co:..puter Program for Quasi-One-Dimensional Compressible Flow With Area Change and Friction for Application to Gas Film Seals

A computer program, AREAX, has been developed which calculates the properties of compressible fluid flow with friction and area change. The program carries out a quasione-dimensional flow analysis which is valid for faminar and turbulent flows under both subsonic and choked flow conditions. The program was written to be applied to gas film seals. This computer program enables the prediction of gas-film-face seal performance when face deformation and/or radial area change is significant. The analysis is especially useful for choked flow conditions. The program must be supplied with the geometry of the seal, the gas properties, the reservoir conditions, the constants for determining the variation of mean friction factor with Reynolds number, and certain togical variables which control output. In general, AREAX performs the following operations in analyzing the flow across a seal, it reads the input data and checks that these data are consistent. When the input have been read, AREAX analyzes the flow for each combination of film thickness and till angle. The program first solves the Mach number equation and determines the Mach number distribution across the seal number may be either a constant or a specified tabulated function of the ratio of the normal distance from the wall to the boundary-layer thickness. By setting the eddy viscosity equal to Zero, nonsimilar laminar boundary layer flows may be computed. Since a finite-difference procedure is used, the effects of variable wall and edge boundary conditions and wall blowing or suction are easily included by modifying the program inputs.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: CDC-6000 Series PROGRAM SIZE: Approximately 1,028 source statements PRICE: Program \$440.00 Documentation \$11.00

PROGRAM NUMBER: LAR-10990

Program to Determine Radiating, Nonadiabatic, Inviscid Flow Over A Blunt Body by the Method of Integral Relations

This computer program was developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, femperature, density, velocity, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations. The program calculates the radiating nonadiabatic flow of air in chemical equilibrium. Results obtained agree with results from inverse and time-dependent techniques. The agreement indicates that this method of solution provides an accurate description of the blunt-body flow field in the subsonic region. The equations which govern inviscid, radiating, nonadiabatic steady flow of equilibrium air over a blunt body traveling at hypersonic speeds are a system of nonlinear partial differential equations derived from the laws of conservation of mass, momentum and energy. The modified method of integral relations is used to transform the governing equations into a set of ordinary differential equations that are numerically integrated to yield the details of the thermodynamic and flow properties within the shock layer. Provisions have been made in the governing equations for coupled radiating flow-field analysis. The governing differential equations are solved by a fourth-order Runge-Kutta integration technique to give shock-layer thickness, shock angle, and the fluxes of mass, momentum, and energy at the body surface. The documentation contains a description of the computer program along with the methods used in the digital approximations, flow charts, instructions for the user, and a test case with input and output listings.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: CDC 6000 Series PROGRAM SIZE: Approximately 3.188 source statements PRICE: Program \$790.00 Documentation \$14.00 PROGRAM NUMBER: LAR-11048

Numerical Solution of the Unsteady Navier-Stokes Equations

A computer program has been developed to solve the unsteady, two dimensional, incompressible Navier-Stokes equations: The numerical method makes use of an iterative solution of a Poisson's equation for pressure followed by an explicit calculation of velocities. Unsteady flow in a two-dimensional, rectangular cavity with the upper wall moving at constant velocity is investigated using the computer program. The calculations start with the fluid at rest in the cavity and continues until no further change occurs in the velocity. Results are given for cavities with aspect ratios of 12, 1, and 2 with a Reynolds number of 100. Results are also given for several Reynolds numbers between 100 and 500 for a square cavity. Calculated velocities from the unsteady Navier-Stokes equations at large times are compared where possible to velocities calculated from the steady Navier-Stokes equations and to the results of steady experiments; good agreement is presented in the docur ientation. A technique for conducting a numerical flow visualization experiment in conjunction with the solution of the Navier-Stokes equations is described. The results of the experiment are recorded on film which may be shown on a projector.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360 PROGRAM SIZE: Approximately 611 source statements PRICE: Program \$350.00 Documentation \$8.5 Documentation \$8.50 PROGRAM NUMBER: LEW-11415

CFNA - Compressible Flow Network Analysis Computer Program

A computer program, CFNA, has been developed which solves the problem of an arbitrarily connected one dimensional compressible flow network with pumping in the channels and momentum balancing at flow junctions. The program has been specifically designed to include pressure drop calculations for impingement flow and flow through pin fin arrangement, as currently found in many air cooled turbine bucket and vane cooling configurations. The calculation part of the program consists of two major subdivisions. The first section computes the compressible pressure drop through a single passage including friction, orifice, and pumping losses. Provision is made for inlet losses, variable geometry, and pin fin arrays. The second part of the program balances flows and press is throughout the network. This is an iterative procedure involving Matrix evaluations. It converges rapidly in most instances. The program alternates between these two sections on a minimum of three times, and reacnes a required tolerance on percentage change of total flow befo a outputing results.

LANGUAGE: FORTRAN IV MACHINE RECUIREMENTS: IBM-7094 PROGRAM SIZE: Approximately 2.898 source statements PRICE: Program \$590.00 Documentation \$13.50 Documentation \$13.50 1. OGRAM NUMBER: LEW-11859

Co:..puter Program for Quasi-One-Dimensional Compressible Flow With Area Change and Friction for Application to Gas Film Seals

A computer program, AREAX, has been developed which calculates the properties of compressible fluid flow with friction and area change. The program carries out a quasione-dimensional flow analysis which is valid for laminar and turbulent flows under both subsonic and choked flow conditions. The program was written to be applied to gas film seals. This computer program enables the prediction of gas-film-face-seal performance when face deformation and/or radial area change is significant. The analysis is especially useful for choked flow conditions. The program must be supplied with the geometry of the seal, the gas properties, the reservoir conditions, the constants for determining the variation of mean friction factor with Reynolds number, and certain logical variables which control output. In general, AREAX performs the following operations in analyzing the flow across a seal: it reads the input data and checks that these data are consistent. When the input have been read, AREAX analyzes the flow for each combination of film thickness and tilt angle. The program first solves the Mach number equation and determines the Mach number distribution across the seaf face. AREAX then determines the distributions across the seal face of pressure; temperature; density; velocity; mean friction factor; Reynolds number; mass and volume flow rates; Knudsen number; seal opening force; center of pressure; and where appropriate, rotational Reynolds number, variables associated with power dissipation, and axial film stiffness. This program should be used when the effects of seal-face distortions are desired and when the radial area change is significant.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,484 source statements
PRICE: Program \$570.00
PROGRAM NUMBER: LEW-12286

Calculation of Supersonic Stream Parameters of a Real Gas from Measurable Quantities

This package consists of a set of subroutines that are designed to calculate flow and thermodynamic properties of a supersonic stream of real gases from measurable quantities. These routines will calculate; (1) the isentropic mass flow rate of gases through subsonic and sonic flow nozzles; (2) the properties of a supersonic stream as determined from the stagnation pressure, stagnation temperature and the pressure on the surface of a static-pressure wedge; (3) the properties of a supersonic stream as determined from the pressure wedge; (3) the properties of a supersonic stream as determined from the pressure and temperature in a plenum upstream of a supersonic nozzle and the stagnation pressure at the exit of the nozzie. The flow and thermodynamic properties calculated by this set of routines include velocity, density, enthalpy, enthropy, and isentropic exponent. These routines are specifically applied to air, nitrogen, oxygen, normal hydrogen, parahydrogen, helium, argon, steam, methane, and natural gas although the routines are apolicable to any gas whose properties are known. This package supersedes LEW-10820 (B69 10222) and LEW-11534 (B72-10352).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 2,600 source statements
PRICE: Program \$450.00 Documentation \$13.00
PROGRAM NUMPER: LEW-12326

Solution of Compressible Flows in Piping Systems

This computer program will determine the steady state flow of an ideal compressible gas in a piping system. The system may involve orifices, heat exchangers, area changes, constant loss factor elements, adiabatic pipes. non-adiabatic ripes, radius bends, and miter bends. Known values must include inlet temperatures. Other values which may be known or unknown are inlet and exit pressures, and flow charts in specific branches of the system. The unknown pressures and flow rates are computed, along with exit temperatures. Total and static pressures, total and static temperatures, and mach number of the flow are computed at each element in the system. Forces on each element and the loss factor for each element are computed together with approximation volume of each series system. The output data includes input data, exactly as punched. Computed output values include mach number, static and total pressure, static and total temperature, loss factor, and forces on each element. Output is grouped by series system and includes flow rate and approximate volume, as well as the connecting junctures. The systems for which flow rates are guessed, and the corresponding systems for which the error is computed is output. Limitations imposed by the program include that the system must be defined by not more than 25 series systems connecting not more than 25 junctures. Three times the number of series systems plus the total number of elements must not exceed 1,000.

LANGUAGE: FORTRAN II (65%), MAP (35%)
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 2,595 source statements
PRICE: Program \$480.00
Documentation \$12.00
PROGRAM NUMBER: MFS-00443

Compressible Flow Computer Program

This program solves problems involving compressible pipe flow with heat transfer through the use of an electrical analogy. To adapt the container data for program usage, the container surfaces are assigned node numbers. To balance the system to be a specified pressure drop, one of two compressible flow solutions can be used: the flow can be fixed and the orifice diameters adjusted or orifice sizes fixed and the flow corrected. Solving for manifold design parameters, the fixed flow routine is first used to determine approximate orifice sizes and flow rates. Container inlet temperature values are compared with the required temperatures and final adjustments are made on the variable flow routine to yield design values for orifice size, flow and temperature.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 471 source statements
PRICE: Program \$140.00 Documentation \$16.50
PROGRAM NUMBER: MFS-14683

KALV - Water Landing Loads Analysis

This program calculates a time history of depth of penetration, velocity, force, load factor, maximum pressure at the water line, and average pressure for a body of revolution impacting water. The nose shape of the body can be conical or a truncated cone frustum with a spherical nose cap. Forces on the body during submergence of the riose section are based on virtual mass theory. For submergence past the nose cone, body motion is determined by hydrodynamic drag. Either a drag coefficient for the body is calculated to balance the forces from the virtual mass theory at the intersection of the cylinder and nose cone or a coefficient of drag can be input to replace the calculated value. Some possible uses of the program are for military ordinance, water recovery of space and military vehicles, dropping of commercial or military payloads from aircraft.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PNOCE :: SIZE: Approximately 280 source statements
PRICE: rogram \$340.00 Documentation \$4.50
PROGRAM NUMBER: MFS-21955

Computer Program for Pressure Drop and Pumping Power for Fluid Flow through Round Tubes

This program calculates the pressure drop and fluid pumping power for flow through round tubes. The equations which are used are referenced in the following manner: Jelinek, D. Active Temperature Control Fluid Systems Preliminary Design for Grand Tour Mission. North American Rockwell Corporation, April 1971. The solution assumes laminar liow and has been designed for steady-state analysis. The program is written for the

Hewlett Packard 9100A electronic desk type computer. The documentation includes a program listing. No "source deck" is available as it is not required. Potential uses of this program include design of air heating duct systems, air cooling duct systems, hot water or steam lines, refrigeration system lines, and hydraulic system lines for use in homes, factories, or automobiles.

LANGUAGE. Data entered at the time of processing MACHINE REQUIREMENTS: Hewlett Packard 9100A PROGRAM SIZE: Not Applicable PRICE: \$25.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MFS-24172

SMAC - Simplified Marker and Cell method for Calculating Incompressible Fluid Flows

The Marker and Cell (MAC) method was previously proposed for the numerical solution of problems concern ing the time-dependent, viscous flow of an incompressible fluid in several space dimensions. A Simplified MAC (SMAC) method is decribed; it has at least as great a range of applicability as MAC, but is significantly simpler to use The Market and Cell (MAC) method is a numerical solution technique for investigating the dynamics of an incompressible fluid. It has been applied to a variety of time-dependent flow problems in several space dimen sions, with results that agree well with experiments whenever comparison data have been available. The technique has several advantages for the calculation of confined flows, as shown in studies of the van Karman vortex street, various types of internal reactor flows, and two fluid problems with surface tension. The advantages of MAC are especially apparent for flows with free surfaces, such as the splashing drop problem, in which the surface configuration is continuously changing with time. Recent investigations have demonstrated, however, that the MAC method is excessively complicated in several respects This is especially true of the boundary conditions, which require derivation that assures precise consistency among the momentum and pressure equations. There is relatively little difficulty for simple configuration, but in the presence of rigid obstacles and various input or output boundaries. both the derivations and the programming logic can become unduly tedious. A second difficulty with MAC is the solution of the Poisson equation, for which direct methods are available only for very simple types of configurations. Both of these inconvenient features are alleviated in the variation of MAC proposed here. In this Simplified MAC (SMAC) technique, the pressure never need be calculated. Accordingly, only the velocity bound ary conditions and the free surface (normal and tangentia) stress conditions are required for the momentum equations, while the Poisson equation for mass conservation needs only homogenous boundary conditions everywhere

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SUE Approximately 700 source statements
PRICE: Program \$450.00 Documentation \$11.50
PROGRAM NUMBER, MSC-17566

DUCT - Adiabatic Compressible Flow Duct Analysis Program

The DUCT computer program models the change in turbine stagnation exhaust temperature with respect to changes in turbine back pressure, so as to incorporate the

effects of turbine efficiency and performance on exhaust duct pressure drop. The actual turbine back pressure (Pt) is determined for any given ambient pressure (PO) by iterating on an assumed back pressure until the static pressure at the exit of an exhaust duct (P2, computed from the Fanno relations) is equal to the ambient pressure.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360 PROGRAM SIZE: Approximately 96 source statements PRICE: \$70.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

Numerical Solution of Transonic Flow in a Convergent - Divergent Nozzle

PROGRAM NUMBER: MSC-19178

In the throat region of a convergent divergent nozzle the flow of a compressible fluid reaches sonic velocity. Due to the wall configuration in the convergent portion of the nozzle, the transonic flow in the throat region is nonuniform. A description of the transonic flow conditions is necessary to determine the mass flow through the nozzle and the supersonic flow field downstream of the throat. A knowledge of flow conditions along the nozzle wall upstream of the throat is useful in estimating the heat transfer to the wall in this region. This package of programs applies various methods in order to solve these flow conditions and give us a simple analytic description of transonic flow in the throat region. The programs use methods which include various functions for boundary values along the nozzle axis, yielding different types of flow field configurations. Any appropriate streamline in the flow field thus constructed can be considered as the nozzle wall contour. The method of calculating the subsonic flow field and the sonic line is discussed in detail in the documentation. A modification to the method of characteristics for calculating the supersonic flow immediately down stream of the sonic line is also described.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 SeriesFROGRAM SIZE Approximately 833 source statements
PRICE: Program \$280.00 Documentation \$12.50
PROGRAM NUMBER: NPO-10895

Computer Program For Analyzing Piping Systems

This program allows mechanical and controls engineers to rapidly analyze complex piping systems. Input data are entered into the machine by means of punched cards—the card format is designed to expedite entry and minimize human error. Output data include the Kw and c values associated with each circuit component (pipe, valve, elbow, reducer, sudden enlargement and contraction, ordice, Potter, etc.). In addition LigA, pipe volume and other data are computed. This information is required for the analog computer simulation of piping systems. A total of three individual flow rates can be input into the program. The computer will then calculate the pressure drop existing across each individual component. Further all output variables can be summed at any time during the calculation, and the final system, c, kw, and pressure drop data are tabulated

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS IBM 360
PROGRAM SIZE Approximately 746 source statements
PRICE Program \$160.00 Documentation \$6.50
PROGRAM NUMBER: NUC-10376

GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; geodesy; hydrology and limnology; geochemistry and geomagnetism.

EXILE/FXIST/IRIS - Mineral Exploration Investment Optimization and Resource Estimation Computer Programs

EXILE. This computer program is concerned with the economics of mineral exploration costs and investments The purpose of the program is to optimize investment policies relating to the search for an exploitable mineral deposit and the development of a deposit into the production stage. The program and documentation present a method by which investments can be kept as low as possible with respect to a sufficient capitalization reserve and the leveling of shock effects due to sudden variations in consumption patterns. The annual stocktable is calculated from annual metal requirements and accumulative reserves. A capitalization scheme is calculated based on the first in first out principle. The unit exploration costs per ton of metal is calculated from the quality of the ore, probable number of deposits, and capitilization product price of the metal. Projections of annual discovery rates are calculated by applying rate and production time. The program does not take into account the costs of the actual capitalizations, only exploration costs and investments (including interest) EXIST. The computer program EXIST optimizes the mineral exploration investments according to the criterions. (1) Sufficient capitalized reserve must always be accessible. (2). Strong variations in exploration activities must always be accessible (3) Expenditures have to be minimal (4) Future adaptations of the economic definition of an exploitable are deposit have to be forecasted and incorporated. The major difference between EXILE and EXIST is given by the tourth criterion' EXIST constructs a forecast on the development of the definition of an unexploitable ore deposit, and calculates the unit exploration costs from the market value of the mineral IRIS. The purpose of the IRIS program is to give an accurate prediction of the quantity of metal within a defined region. The method applies a Emited binominal expansion to the distribution of a metal within a certain area. The formulation is such that a single constant defines the dispersion of the metal in the considered region. The actual value of the constant can be calculated out of the known reserves. Sequentially the distribution of ore deposits of any size and grade can be calculated. IRIS can also calculate the distributions of minerals according to the log normal theory for comparison with the present results. These programs operate in tatch mode and use the Calcomp plotter

LANGUAGE FORTRAN (90%) ASSEMBLER (10%) MACHINE REQUIREMENTS: IBM 360 PROGRAM SIZE: Approximately 618 source statements PRICE Program \$250.00 Documentation \$15.50 PROGRAM NUMBER: COS-02540

Geomagnetic Field and Field Line Calculation Computer Program

A set of computer programs has been developed for the calculation of the geometric field and the tracing of field lines in space. The basic subroutine, geocentric ALLMAG. contains coefficients for seven recently published field models as built in data statements. At execution time the user can vary the model and for the time period simply by changing input parameters. Subroutine GDALMG are equivalent to Cain's FIELD AND FIELDG, with the added flexibility of the choice of seven models. LINTRA traces field lines from any point in space to a specified altitude intersect in the same or opposite hemisphere, using any of the models contained in ALLMAG Input is in either geocentric or geodectic coordinates, and output is returned in both. McIlwain's INVAR package, which calculates B and L, has been adapted to use ALLMAG. The program was checked on IBM 360-65 but innovator notes. that it was tested with equal success on IBM 360 (40, 75, and 91), CDC 6600, IBM 7094, and UNIVAC 1108

LANGUAGE FORTRAN IV.
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,844 source statements
PRICE Program \$600.00 Documentation \$7.50
PROGRAM NUMBER: GSC-11597

SSCO1 - Statistical Summary of Climatological Data Computer Program

This program performs a statistical analysis of surface wind observations. The observations consist of wind velocity and direction recorded hourly for each day of the year. Input to the program consists of the monthly observations of wind velocity and direction. The wind velocity data are sorted by the program into 10 velocity ranges for each 17 wind direction ranges. The program then summarizes the observations by the hour for each month and performs the following statistical calculations: (1) The percentage of frequency of wind direction by wind velocity. (2) Total number of observations by wind direction, and by wind velocity. (3) Sum of the wind direction and by wind velocity. (3) Sum of the wind

velocities by wind direction. (4) Mean wind velocity by wind direction. (5) Monthly mean wind velocity. (6) Percentage frequency of each wind direction and velocity range. (7) Sum of the individual wind velocities squared. (8) Standard deviation of the wind velocity based on all wind directions. Output from the program is a tabular summary of the calculations by the hour for each month. The program has the optional capability of recording the summarized data on tape for historical purposes. This tape contains 12 files of data, one for each month of the year. This historical tape may then be updated on a menthly basis by combining the current month's data with the previous year's monthly data. Statistical calculations are then performed with the updated summary information and the cumulative monthly statistics are output in tabular form.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: GE 635

PROGRAM SIZE: Approximately 358 source statements PRICE: Program \$370.00 Documentation \$7.50

PROGRAM NUMBER: KSC-10425

Handbook For Estimating Toxic Fuel Hazards

This package consists of a program which calculates the drift and fall of air borne materials. It was developed to model concentration, dosage and settling of toxic fuels emitted in the atmosphere, but can be applied to pollution studies of any materials where atmospheric layer structures, position, concentration, diffusion parameters, velocity and distribution of particle size can be determined. The program initially was used for studies in the 0-5 kilometer region of the atmosphere, but has been used for materials at a height of 30 kilometers. Certain assumptions about meteorological conditions are necessary, but accompanying documentation illustrates how these assumptions have been made with a reasonable degree of accuracy. Input parameters are of type types, meteorological inputs required to model atmospheric conditions, and source inputs which incorporate characteristics of the air borne substance being studied. Both types of inputs may be used in a single equation. For example, material concentration is calculated by: Concentration=(Peak Concentration Term) X (Alongwind Term) X (Lateral Term) X (Vertical Term) X (Depletion Term) where (a) Peak Concentration is the concentration at a point defined by Gaussian Coordinates. (b) The alongwind term is defined by wind speed and time of cloud travel. (c): The Lateral term is defined by the position of the source material (d) The Vertical term is defined by the height of the source material, and (e). The Depletion term is defined by material loss due to simple decay processes such as gravitational settling. The amount of material disposited on the ground surface is calculated by making three principal assumptions: (1) the rate of precipitation is constant over a large area: (2) precipitation originates at a level above the toxic cloud; and (3) precipitation time has a distinct relationship to horizontal cloud movement. The program consists of 22 subroutines and is written in ASA FORTRAN V, though currently written for UNIVAC it should execute under most high level FORTRAN compilers when the appropriate monitor control cards are used

LANGUAGE: ASA FORTRAN V
MACHINE REQUIREMENTS UNIVAC 1100 Series
PROGRAM SIZE. Approximately 1.877 source statements
PRICE Program \$710.00 Documentation \$52.50
PROGRAM NUMBER: MFS-21114

Four-Dimensional World Wide Atmospheric Models

This package consists of two programs, ANYPT and ANYRG, and a set of magnetic data base tapes which are input to the programs. The data base utilized by ANYPT contains one file for each month of the year. Each of these files contains records representing atmospheric parameter values at 3490 grid points over the globe. Each record contains the pressure means and variances, the temperature means and variances, the moisture means and variances and the density means and variances for any height from 0 to 25 km a 1 km intervals. Using this global data set, ANYPT will generate for any month unique meteorological profiles consisting of tables of monthly means and variances for pressure, temperature, absolute humidity and density for any latitude, longitude and level up to 25 km. Where data for a selected grid point is not available, ANYPT will take existing data and, using horizontal interpolation schemes, apply it to any location on the globe. In addition, ANYPT contains the option of curve fitting the profiles generated for any data point so that meteorological parameter values may be extrapolated to any height in the range 0 to 25 km. Program ANYRG accepts as input data curve fit coefficients for each meteorological parameter averaged over each month and selected grid points within 45 homogenous moisture regions defined across the globe. ANYRG then generates meteorological profiles at specific times and locations from the coefficients of the curve fitted region data. The values produced are not unique for each latitude and longitude for they are constant throughout a homogenous moisture region. However, the execution efficiency of ANYRG relative to ANYPT, recommends ANYRG in those applications where tesser precision in generated profiles can be tolerated

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1108
PROGRAM SIZE: Approximately 1.960 source statements.
Approximately 41,000 data records (4-2400 ft. magnetic tapes)
PRICE: Program \$420.00 Documentation \$30.00
PROGRAM NUMBER: MFS-22838

A Program for Computing the Brightness Temperature of a Clear Atmosphere From Radiosonde Data

In the spring of 1971, the losses in the antennas, waveguides, and radomes of the Multi-Frequency Microwave Radiometer (MFMR) were being determined by measurements made at Table Mountain, California. In these determinations, the brightness temperature of the sky must be known. The purpose of this computer program is to calculate the angular distribution of sky brightness temperature at microwave frequencies from radiosonde data. A radiosonde is a ballocaborne device that measures pressure, temperature, and relative humidity. Soundings of these quantities are obtained during the ascent of the radiosonde from the surface to an altitude at which the balloon breaks. The following must be considered in making the angular distribution of sky brightness temperature at microwave frequencies from radiosonde data: (1) The radiosonde data and its shortcomings; (2) The radioactive transfer problem; and (3) The relationship between the radioactive and meterological properties of the atmosphere. After selecting a set of mathematical expressions to describe the microwave transfer process. these equations are then programmed in a format compatible with the input data and the needs of the data reduction program. The atmosphere is assumed to be composed of a number of homogenous, spherical shells overlying a spherical surface that has a radius four-thirds that of the earth. The meteorological properties of each shell are taken to be the arithmetic means of the values of these properties at the boundary of the shell as given by the radiosonde data. No liquid water is assumed to exist in the atmosphere

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 396 source statements
PRICE, Program \$190.00 Documentation \$6.50
PROGRAM HUMBER: IASC-14093

AIRPOL—Wind Trajectory Tracing for Air Pollution Studies

This program performs the task of tracing the path of an air parcel as a function of time. The value of this program is that (1) it can provide data on the areas affected by an air pollution source or (2) if a monitoring station detects a pollutant, the upstream path of the air can be traced, and the potential pollution sources can be narrowed considerably. The program is a non-real time program. The program takes, as input data, wind vectors wind station parameters, and the locations of the desired starting points. The program computes and lists the air parcel locations in half hour steps, either for the duration of time span requested, or until no wind vector date is available. The program traces a non-dispersing wind parcel either forward or backward in time and does so in two dimensions.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: 18M-360
PROGRAM SIZE: Approximately 1.168 source statements
PRICE: Program \$370.00
PROGRAM NUMBER: NPO-11892

QUAL 1 - Simulation of Water Quality in Streams and Canals

A computer program, QUAL-1, is one of two computer programs developed by the Texas Water Development Board for use in stream quality simulation studies, QUAL-1 was developed to simulate the spatial and temporal variations of several specific water quality parameters in streams and canals. These parameters are: (1) Temperature; (2) Biochemical Oxygen Demandi Dissolved Oxygen (BOD/DO), and (3) Conservative Minerals. The program routes these parameters through a system of streams and canals on an hourly basis. It assumes that the major transport mechanisms, advection and dispersion, are significant only along the main direction of flow (longitudinal axis of the stream or canal). It allows for multiple waste discharges, withdrawls, tributary flows, and incremental runoff. It also has the capability to compute required dilution flows for flow augmentation to meet any prespecified dissolved oxygen level. The program is designed to begin the routing calculations from the points farthest upstream (headwaters) of a stream or canal system. As incremental flows and waste inputs or withdrawals are encountered, they are entered into the calculations. The result at the end of the system is a set of simultaneous equations equal in number to the number of computational elements in the system. This set of equations is solved, thus advancing the solution forward in time. This proce dure is repeated until steady state conditions are reached. which is approximately the time required for a water particle at the uppermost point in the system to reach an end of the system. The user has seven (7) options to choose from: (1) Route temperature, BOD/DO, and conservative minerals; (2) Route temperature and BOD/DO; (3) Route BOD/DO; (4) Route conservative minerals and temperature; (5) Route temperature; (6) Route BOD/DO and conservative minerals; and (7) Route conservative minerals. The user has the option to determine flow augmentation requirements based on preselected minimum allowable dissolved oxygen concentrations if he so desires. The program has the following restrictions: (1) Maximum number of reaches = 25; (2) Maximum number of headwaters = 5; (4) Maximum number of junctions = 5; and (5) Maximum number of computational elements = 500.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Can be run on any computer
with a FORTRAN IV compiler if minor modifications are
made. The program has been operational on the RCA
SPECTRA 70/45, the CEC-6400 and 6600, and the
UNIVAC-1108
PROGRAM SIZE: Approximately 2,134 source statements
PRICE. Program \$680.00 Documentation \$16.50
PROGRAM NUMBER: UGA-02333

DOSAG 1 - Simulation of Water Quality in Streams and Canals

A computer program, DOSAG-1, is one of two computer programs developed by the Texas Water Development Board for use in stream quality simulation studies. DOSAG-1 is used to simulate the spatial and temporal variations in biochemical oxygen demand (BOD) and dissolved oxygen concentration (DO) under various conditions of temperature and headwater flow. Its principal use is for rapid evaluation of a number of varying stream conditions. The purpose of the model is to calculate the BOD/DO in a particular stream system. If desired, the minimum DO in the stream system may be checked against a pre-specified target level DO. If the minimum DO level is below the target DO, the program will compute the required amount of flow augmentation to bring the DO level up to the target level in the entire system. The user specifies the locations within the stream system at which dilution water is available for flow augmentation. The program is designed to be run for varying climactic and hydrologic conditions during a twelve month period. Thus, it is possible to enter up to twelve different temperatures and corresponding discharges to each of the headwaters within the stream being modeled. The output from a single run of the DOSAG I program will provide a complete description of the DO resources of the stream system investigated, and the required dilution water needed to bring the system up to the target level DO. An additional user option available is the ability to find the DO distributions for varying levels of treatment (waste treatment plants) in the simulated river basin. The program has the following restrictions: (1) Maximum number of headwater stretches = 10; (2) Maximum number of junctions = 20; (3) Maximum number of reaches = 50, (4) Maximum number of stretches = 20; (5) Maximum of twelve months of routing for temperature and headwater flows; a minimum of one month must be used (6) Maximum number of dissolved oxygen targets = 4, with a minimum of one specified, which could be negative if no flow augmentation is desired. (7) Maximum of five degrees of treatment for both carbonaceous and nitrogenous wastes, with a minimum of one specified. The user does not have to exercise this option.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Could be run on any computer that has a FORTRAN IV compiler

PROGRAM SIZE: Approximately 1.132 source statements PRICE: Program \$670.00 Documentation \$9.00 PROGRAM NUMBER: UGA-02340

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: Could be run on any computer that has a FORTRAN IV compiler

PROGRAM SIZE: Approximately 1.132 source statements PRICE: Program \$670.00 Documentation \$9.00 PROGRAM NUMBER: UGA-02340

INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; sensors and transducers; photography (including optical, aerial, and radar photography); infrared technology; display systems; data recording and processing.

Optical Systems Ray Tracing

This program traces rays of light through optical systems consisting of up to 65 different optical surfaces and computes the aberrations. For design purposes, paraxial tracings with astigmatism and third order tracings are provided. The procedure accounts for various filts of the surfaces with respect to the optical axis which are introduced either by design or by manufacturing tolerances. Five different types of optical surfaces are treated, and provision is made to test for each type. Also, the computations are carried out for three different values of the refractive index. Provision is made for introducing new surfaces, or variations of the original ones, into the system after the computations for the original have been made The input of all variables is on cards. The basic coordinate system used is a right handed Cartesian system with the positive Z axis directed along the optical axis, the Y-axis directed positive vertically, with the X axis completing the right handed system. An option to run several types of systems at once is available, which gives the advantage of computing large numbers of experiments in only one pass on the computer

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS. GE 635
PROGRAM SIZE. Approximately 1,677 source statements
PRICE. Program \$440.00 Documentation \$13.50
PROGRAM NUMBER: FRC-10017

OSRT1 - Optical Systems Ray Tracing Computer Program

A computer program has been written which prevides efficient handling of optical analysis equations from both the general skew and paraxial ray standpoints, yet is sufficiently general in approach as to accept a wide variety of systems introduced in a convenient form. Meaningful diagnostic messages are generated to help the user pinpoint any incensistencies of the system definition. The program uses standard optical system analysis equations as outlined in such publications as the "Military Standardization Handbook of Optical Design." It is designed to trace the exact paths of up to 800 representative rays through any number of symmetric or asymmetric optical systems.

Rays may also be traced through a paraxial ray trace, two rays at a time. The functions of the program are segmented enough so that, while each segment is not autonomous, the functions contained within each segment are well defined to facilitate conversion to other computers or other languages, and to enable changes in method to be incorporated easily. The program is sufficiently general in approach to accept a large spectrum of systems defined bynormal, tilted, or decentered planar surfaces. Solution ally symmetric quadric, aspheric and deformed spheric and conic surfaces may be imput in any combination up to 22 surfaces per system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 3000L
PROGRAM SIZE: Approximately 2.811 scurce statements
PRICE: Program \$540.00
Documentation \$14.50
PROGRAM NUMBER: GSC-11393

SMIPS - Small Interactive Image Processing System

The Small Interactive Image Processing System is designed to facilitate the acquisition, digital processing, and recording of image data as well as pattern recognition in an iteractive mode. The system contains approximately 104 routines and application programs designed for ease of communication with the computer by personnel who are not expert programmers, fast response to requests for information on pictures, complete error recevery, and simplification of future programming efforts for extension of the system. SMIPS is intended as an experimental system allowing a quick familiarization with the character istics of the image data rather than a production system. It can, however, be used for production work and its fullcompatability with the VICAR System allows access to numerous image processing programs in the VICAR library. Because of its modular design, new interactive capabilities can be easily included and SMIPS could be used as an experimental tool to gain further experience for the design of larger and more conhisticated interactive image processing systems. Digital image processing involves the pictorial or numerical display of raw image data, the restoration or enhancement of images, the display of results as maps or photographs and the

detection of objects. This requires examination of the image data from many different view points and the SMIPS system has been developed to give the user flexible and convienent control of a variety of image-processing methods. SMIPS serves for: (1) Fast display of parts of pictorial data on the screen of an IBM 2250 display device either numerically or as a character representation. (2) Computation and display of histograms. (3) Convenient specification of a variety of image processing tasks for restoration, enhancement and detection. (4) Output of numerical results and pictures as graphs, maps and photographs.

LANGUAGE: ASSEMBLER (60%) FORTRAN IV (40%) MACHINE REQUIREMENTS: IBM 360

PROGRAM SIZE: Approximately 46,690 source statements PRICE: Program \$2,180.00 Documentation \$18.00 PROGRAM NUMBER: GSC-12079

CONVERT - Technique and Computer Program for Calculating Photographic Film Density Variations

This computer program converts digitized film densities of aerial photographs into a number representing the film density difference between the unexposed film border and a point on the photograph. The program contains several subroutines which allow the calculation of the angle off the principal axis of the camera lens so that a correction can be made for vignetting and atmospheric backscattering. The program also plots the computed values as a function of position on the photograph so that a three dimensional picture is produced. Ranges of density difference can be predetermined, and the program will place each data point into its corresponding range so that the percentage of points in each range can be calculated. There are seven steps in calculating the film density difference: (1) the average density of the unexposed film border is calculated (AVERAGE); (2) the density difference between AVERAGE and the density for a specific data point is calculated; (3) the vertical pen distance traveled by the recording plotter pen is calculated; (4) the angle off the principle axis of the camera lens is calculated; (5) a correction factor is calculated; (6) the corrected vertical pen distance is calculated. (7) the film density difference value is calculated. The lens principle axis is assumed to be the same as the perpendicular vertical intersecting the center point of the photograph. The program has utility in the area of remote sensing and was developed to remotely determine water quality. The program sperates in batch mode, uses the Calcomp plotter and is presently running under the Scope 3.0 operating system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE. Approximately 399 source statements
PRICE: Program \$370.00
PROGRAM NUMBER: LAR-11873

Instrumentation Reliability Analysis Program

This program is used for instrumentation reliability analysis. This history tape can be added, deleted, and modified, all in one job. Analysis only jobs can be processed using the same program deck with no increase in computer time or change in input format. Used properly, this program will reveal faulty equipment, improper recall period, or some other failure condition. Output consists of twelve categories: (1) Listing of all instruments that failed, (2) Mean time in weeks to failure of population, (3) Mean time in weeks to failure of population, consisting of those instruments that failed,

(4) Percentage of failure of population, (5) Average repair time per instrument, (6) Total number of instruments analyzed, (7) Period in weeks over which entire population is analyzed, (8) Component and failure mode correlation, (9) Frequency analysis of component parts, (10) Equipment failure symptoms analysis, (11) Component failure symptoms analysis, and (12) Failure cause analysis.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 690 source statements
PRICE: Program \$160 00 Documentation \$4.50
PROGRAM NUMBER: MFS-18483

Digital Image Registration Method Based Upon Binary Boundary Maps

This program uses binary boundary maps to register ground scene images from remotely sensed earth observation data. In change detection, data is acquired from the same ground scene at different time intervals; therefore, registration is a necessary part in determining changes that occur in the ground scenes.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 375 source statements
PRICE: Program \$50.00
Documentation \$6.50
PROGRAM NUMBER: MFS-23033

ASTEP - Algorithm Simulation Test and Evaluation Program

This package represents a data analysis program used to examine statistical properties of multispectral scanner data. It serves as a tool to perform experiments to gain understanding of the problems associated with processing multispectral earth resources data and to test and evaluate processing algorithms. Examples of the experiments of this type include the following investigations: (1) quantitatively determining the variation in spectral signatures for a given situation, (2) determining if there are patterns in the signature variation, either spectrally or spatially, (3) determining the statistical homogeneity of typical ground truth sites. (4) determining if the statistical assumptions required for maximum likelihood processing of typical areas are satisfied, (5) evaluating the performance of various clustering techniques, and (6) comparing the performance of clustering and maximum likelihood algorithms. Since the last version of ASTEP, a number of new capabilities have been added. Some of these were made to improve the overall efficiency of the program and will be transparent to the user, others include changes in input option and some new options. A main feature of this updated version is that it can accept input data in LARSC1, LARSC2. ERTS, and Universal formats, and output processed image or data tapes in Universal format. Also an error recovery capability has been added to prevent the program from terminating when errors are made in the namelist input. The program now consists of two basic parts, a driver and a set of application modules. The driver serves several functions. It is the holder of the common storage areas and transfers control to the appropriate applications module. The application modules consist of data classification and display algorithms; data statistical analysis subroutines; feature selection; utility options; and program information options. ASTEP consists of over a hundred subroutines and operates in either interactive or batch mode

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series EXEC 8
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR Formatted Tape
PRICE: Program \$970.00 Documentation \$35.00
PROGRAM NUMBER: MSC-14690

LARSYS III - Multispectral Data Analysis System, Release 3.1

The LARSYS software system is designed for remote sensing research. The system uses pattern recognition and interactive data handling techniques applied to remotely sensed multispectral and/or multitemporal data The primary input data to LARSYS is multispectral data in image orientation. Such data has been obtained from aircraft or spacecraft multispectral scanners. These images of the earth's surface are either recorded in or converted to digital data for input to LARSYS. LARSYS has found application in the areas of agriculture, geology, hydrology, and geography, but LARSYS facilitates the application of remote sensing for researchers in other disciplines as well. The basic analysis concept of LARSYS consists of locating data points which are believed to be representive of classes of interest. A class of interest may be certain crops, beaches, woods, geological features, etc. Gaussian statistics of these data points (a key assumption made in several LARSYS algorithms is that distributions are Gaussian) are calculated and data sets are classified by spectral similarity. Next, the classification results are evaluated. Thus, there are four basic concepts to the analysis: (1) location of data points, (2) statistical calculations, (3) classification, and (4) process evaluation. LARSYS will operate in batch, interactive or disconnect mode, and as distributed is implementable on IBM 360 machines. The current configuration includes 512K bytes of main storage, about 200 million bytes of auxiliary direct access storage, 10 tape drives, 2 card readers, 2 printers. I card punch, 10 remote typewriter terminals, 3 remote reader printer punch high speed terminals, and an IBM 4507 Digital Display System developed especially for LARSYS LARSYS options allow for the installation of the software on a configuration which represents only a subset of the present hardware system. The operating system environment includes the IBM supplied Control Program-67; the Cambridge Monitoring System (for virtual machine operation); a FORTRAN IV compiler identical to the OS G level compiler; and the OS: 360 Assembler. Documenta tion for LARSYS consists of four different manuals Multiple documentation prices are available for LARSYS The LARSYS Users Manual contains a comprehensive description of the functional organization of the system, the processing functions provided, and the manner in which the functions are invoked and controlled. The LARSYS System Manual is directed primarily to programmers and analysts who maintain or revise the system or write new functions that must be interfaced with LARSYS The LARSYS System Program Modules Manual contains the documentation of each FORTRAN and Assembler routine and each Cambridge Monitoring System Executive routine in LARSYS. The LARSYS Test Procedure Manual is the basic document to be used for verifying the proper functioning of the LARSYS Program System as defined in the Users Manual and the Systems Manual. The LARSYS program product is available by lease only for a one-time minal fee of \$1,000 to domestic U.S. tessees and \$2,000 to foreign lessees. The leased program product delivered includes one complete set of supporting documentation, however, additional documentation may

be purchased separately at any time (Prices available from COSMIC on request).

LANGUAGE: IBM FORTRAN IV (G) and IBM Assembler MACHINE REQUIREMENTS: IBM 360 DISTRIBUTION MEDIA: 9 Track, 800 BPI Magnetic Tape PROGRAM NUMBER: MSC-14323

FOLDP—FORTRAN Optical Lens Design Program

This program utilizes the principles of geometric optics to design optical systems containing up to 100 plane, conic or polynomial asyheric surfaces, 7 object points, 6 colors and 200 rays. Any number of cases can be processed in a single computer run. The program is made up of 48 subroutines. In the design phase, it uses a linearized least squares technique to iteratively reduce the magnitude of the ment function by automatically adjusting system parameters. The ment function is made up of the sum of the squares of the user-weighted aberrations of the system. The ray trace capabilities of the program can be used individually, by option, to find focal point, focal length, back focus, f number and exit pupil location for every color.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094/SC 4020 plotter
PROGRAM SIZE: Approximately 7.077 source statements
PRICE: Program \$680.00 Documentation \$52.00
PROGRAM NUMBER: NPO-10603

VICAR: Vicar Image Communication and Retrieval System

The VICAR system consists of an expandable library of application programs and a supervisory control program and is designed to facilitate the acquisition, digital processing, and recording of image data. The application programs perform the various image processing functions of picture comparison, expansion, two dimensional convolution filtering, geometric transformation, and other image enhancement functions. The image analyst using VICAR calls for the automatic execution of one or more of the library programs, including the requisite image data management services, through a set of command instructions supplied to the control program which serves as a communication medium beteen the user and the program library and is always resident in central memory. Because the library programs are written to be flexible in application, the analyst supplies the parameters specific to a particular application at execution time through command language operands. Utilization of the VICAR command language to accomplish picture processing requires a minimum of programming knowledge and data inputs from the analyst. The system also utilizes and provides efficient special purpose input output routines designed for image data transfer which reduce library and central memory storage requirements as well as obviating the necessity for writing these for each processing program Currently the application program library contains in excess of 200 processing programs which may be easily arigmented with additional programs using standard VICAR support facilities. Two versions of the VICAR system are available through COSMIC differing only in the host computer operating system requirements. One version (NPO 13415) requires the IBM 360 44 Programming System (44-PS) monitor while the other (GSC-12706) is implementable under the IBM 360/370 OS monitor.

LANGUAGE: FORTRAN (60°L), ASSEMBLER (40%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 82,000 source statements
PRICE: Program \$1,670.00 Documentation \$88.00
PROGRAM NUMBER: NPO-13415, GSC-12076

MACHINE ELEMENTS AND PROCESSES

Includes bearings and gears, seals, pumps, vacuum technology; lubrication and lubricants; friction and wear; materials fabrication; numerically controlled machining; manufacturing processes and quality control; structures and component reliability analysis.

Systems Identification Using A Modified Newton-Raphson Method

A digital computer program written in FORTRAN is offered which computes a maximum-likelihood estimate of the parameters of a linear, state space model. For the case considered, the maximum-likelihood estimate can be identical to one which minimizes simultaneously the weighted mean-square difference between the computed and measured response of a system, and the weighted square of the difference between the estimated and a priori parameter values. A modified Newton-Raphson or quasilinearization method is used to perform the minimization which typically requires several iterations. The modification of the Newton-Raphson method was made in the interest of reduced computation and program simplicity. A starting technique is used which insures convergence for any initial values of the unknown parameters. A Cramer Rao bound is used to indicate the variance of the estimated parameter values. Although the primary appli-cation of the program has been to determine aircraft stability derivatives from flight data, it is directly applicable to identification of any system which can be described by a linear, constant-coefficient model. The intent of this paper is to describe the program and its operation in sufficient detail to enable the user to apply the program to his particular problem with a minimum of difficulty.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 700 source statements
PRICE: Program \$380.00 Documentation \$12.00
PROGRAM NUMBER: LAR-112S1

Investigation of sothermal Compressible Flow Across a Rotating Sealing Dam

This computer program analyzes by means of a mathematical model the flow across a parallel sealing dam of a shaft face seal. The analysis is for steady, laminar, subsonic, isothermal compressible flow with rotation of one of the sealing dam surfaces. The effect of rotation on mass flow, pressure distribution, and other physical

parameters is determined. Some power plants, such as advanced let engines, exceed the operating limits of face contact scals. As a result, noncontact face seals are becoming necessary if high leakage associated with labyrinth seals is to be avoided. The effects of relative rotation of the sealing dam surfaces on the radial pressure flow does not presently exist in the literature. To achieve a good design, it is desirable to study the effect of the variation of a large number of parameters; thus, the automatic calculation and printout of physical variables facilitates design. The program requires the following input variables: the dimensions of the seal, pressure boundary conditions, and molecular weight and physical properties of the gas. The output includes mass flow rate, pressure and velocity distribution, Mach number, force, center of pressure, rotational flow Reynolds number, pressure flow Reynolds number, power loss, torque, and approximate temperature rise due to viscous shearing for specified film thicknesses.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 11/7044 or 7040
DCS under IBSYS Version 13 using ALTIO
PROGRAM SIZE: Approximately 891 source statements
PRICE: Program \$280.00 Documentation \$12.00
PROGRAM NUMBER: LI.N-11033

Computer Program for Calculating the Temperature Field of Face Seals

This program was developed for the calculation of the temperature field of shaft-seals, but it is general and can be applied to a variety of stead, state thermal problems. Staft seals are composed basically of axisymmetric bodies. The circumferential temperature gradient approaches zero for most applications, thus the cylindrical coordinate system is used as a basis for analysis. Various convection and radiation boundary conditions which can be used are given in the developed mathematical formulations. The program is designed to permit ready substitution or addition of other boundary conditions or other expressions for the heat transfer coefficients. The calculation procedure requires that the axisymmetric

bodies be divided into an arbitrary finite number of axisymmetric volume elements or nodes which need not be equal in cross-section. The program takes into account contact resistance at the interface between nodes and material properties that vary from node to node. Provisions are made to handle varying gas temperatures along the seal boundaries and internal viscous heat generation within the fluid at the boundaries. A subroutine, normally vendor supplied, is missing from this program and must be furnished by the purchaser. The subroutine name is TIMEI.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7C34

PPOGRAM SIZE: Approximately 1,716 source statements PRICE: Program \$200.00 Documentation \$13.00 PROGRAM NUMBER: LEW-11110

Evaluation of Rotating Incompressibly Lubricated Pressurized Thrust Bearings

An analysis and computer program have been developed which permit the rapid evaluation of pressurized thrust bearing designs using an incompressible lubricant. Included in the analysis are the effects of two self-acting journal bearings which may be used to provide a radial load capacity. Bearing load, torque, lubricant flow rate, and other quantities of interest can be calculated. Either orifice or capillary restrictors may be used and effects of bearing rotation are included. A review of the literature indicates that there is no published information on rotating, compensated, pressurized thrust bearings using incompressible lubricants. The program was used to evaluate a series hybrid, fluid-film ball bearing. For the fluid-film bearing, an orifice compensated pressurized thrus bearing in conjunction with a self-acting journal bearing was used. Oil viscosities corresponding to experimental., measured ball bearing outer-race temperatures were used in the computer program. Points for the analytical curve were obtained from plots using measured bearing torque. The analysis indicated that when the supply pressure became high enough to lift off the fluidfilm thrust bearing, the intermediate speed dropped abruptly. After lift-off, the intermediate speed would rise at a slightly lower rate than shaft speed. Results of the computer program agreed well with experimental data.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 or others with
FORTRAN IV compiler
PROGRAM SIZE: Approximately 250 source statements
PRICE: Program \$250.00 Documentation \$5.00
PROGRAM NUMBER: LEW-11511

FORTRAN Programs for the Design of Liquid-to-Liquid Jet Pumps

Five computer programs have been written, based on one-dimensional equations, for the selection and design of liquid-to-liquid jet pumps for noncavitating and cavitating flow. Each program operates on a specific combination of input parameters and provides a set of output parameters which enable a designer to choose a pump. There are five programs because there are five common design situations, each carrying a unique set of "known" parameters and requiring another set of output parameters to specify a design. The five design programs have the following input and output elements: P1=Primary total inlet pressure; P2=Secondary total inlet pressure; P0=Outlet total pressure; W1=Primary fluid weight flow; W2=Secondary fluid weight flow; M2=Secondary fluid weight flow; M3=Flow Ratio, W1/W2; An=Area of primary

nozzle exit plane; At=Area of throat; and R=Area Ratio, An/At. The major advantages to each program are: Program I-Design chart development; Program II-Kriewn throat diameter; Program III-Marginal cavitation limits: Program IV-Known flow rate and pump pressure rise; and Program V-Off-design performance from known pump geometry. The programs may be used for any liquid for which the physical properties are known. Calculations for noncavitating and cavitating performance were combined, permitting a calculation of cavitation limits within the program. Design charts may be developed without the manual iteration which is common to existing design methods. The programs are adaptable in use. Single-pass design point calculations may be made if the design requirements are fully specified. Or, if some of the parameters are variable, one or more programs may be used to construct elaborate design charts.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 420 source statements
PRICE: Program \$340.00 Documentation \$7.50
PROGRAM NUMBER: LEW-11679

Computer Program for Calculating Critical Speeds of Rotating Shafts

This computer program has been written to calculate the critical speeds of rotating shafts. The shaft may include bearings, couplings, extra masses (nonshaft mass), and disks for the gyroscopic effect. Shear deflection is also taken into account and provision is made in the program for sections of the shaft that are tapered. The boundary conditions at the ends of the shaft can be fixed (deflection and slope equal zero) or free (shear and moment equal zero). The fixed end condition enables the program to calculate the natural frequencies of cantilever beams. The program uses continuous integration of the differential equations of beam flexure across different shaft sections. In the program output a plotter is used to produce a drawing of the shaft with superimposed deflection curves at the critical speeds together with all pertinent information related to the shaft.

LANCUAGE: FORTPAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 866 source statements
PRICE: Program \$370 00
PROGRAM NUMBER: LEW-11910

Program for Calculating Total Efficiency - Specific-Speed Characteristics of Centrifugal Compressors

A computer program has been developed for predicting design point specific speed efficiency characteristics of centrifugal compressors. Compressor efficiency has been shown to be a function of specific speed. Specific speed is a characteristic that relates compressor inlet volume flow rate, rotation speed, and ideal enthalpy rise. Generally, high efficiencies are associated with high specific speeds, and low efficiencies are associated with low specific speeds Compressor design point geometries that produce maximum attainable efficiency are also functions of specific speed. Knowing the variation in optimum design point geometric variables with specific speed permits rapid selection of high efficiency configurations. This computer program uses a one-dimensional mean streamline analysis conducted at fixed stagnation conditions. Seven specific losses are calculated for each set of compressor geometric variables and inlet velocity diagram characteristics studied. These are inlet guide vane, blade

loading, skin friction, disk friction, recirculation, vaneless diffuser, and vaned diffuser losses. Each of these individual losses is expressed as a decrement in compressor total efficiency. The effect of these losses is then related to overall compressor total efficiency. The effect of these losses is then related to overall compressor performance and specific speed. By examning the program output, the user can select values of inducer hubtip diameter ratio, inducer tip exit diameter ratio, impeller blade exit backsweep, impeller exit blade height-diameter ratio, and impeller exit absolute flow angle that will result in maximum total efficiency for the chosen application. For given inlet stagnation conditions, the user can generate efficiency, pressure ratio, specific speed, and relative loss distribution data corresponding to various combinations of impeller inlet velocity diagram characteristics and impeller overall geometries. By examening the output data, a compressor geometry can be chosen which will yield maximum efficiency under the constraints imposed. The following categories are used as input information: (1) compressor geometry, (2) thermodynamic properties of the working fluid, (3) velocity diagram characteristics, and (4) iteration limits. The prewhirl used in this analysis is solid-body vortex. For iterations on inducer tip absolute critical velocity ratio, the inducer tip speed is adjusted to preserve inlet velocity triangle similarity with that determined by the first pair of input inducer tip speed and inducer tip absolute critical velocity ratio. That is, the absolute and relative flow angles are held constant for successive iterations. For each iteration, the following culput information is tabulated; compressor geometry, velocity diagram characteristics and compressor performance characteristics. The program can be used for working fluids other than air which approximates ideal gas behavior since the thermodynamic properties needed for the equations solved in the programs are specified inputs. If a working fluid other than air is used in the analysis, an empirical equation expressing the dynamic viscosity as a function of temperature must be substituted.

LANGUAGE: FORTRAN (83°), MAP (17°) MACHINE REQUIREMENTS: IBM-7094 PROGRAM SIZE, Approximately 460 source statements PRICE: Program \$370 (2) Documentation \$7.50 PROGRAM NUMBER: LEW-12008

Bellows Calculation Program, IBM 360 Version

This program employs empirical and analytical derived design equations on various metal bellows of different sizes in order to calculate various properties of bellows used in ducting systems. Arithmetic operations are performed in double precision. Calculations are restricted to four single bellows movements and two double bellows movements. One subroutine and one data deck are required with the main program. The main program and the subroutine calculate bellows spring rates, bulging, bending, and hoop stresses. Cycle life is calculated by the data deck. With known bellows dimensions and type of movements supplied as data, the main program and subroutine calculate spring rate, actuating force, squirming pressure, stress, bellows weight, resonant frequency, fatigue, life and convolution clearing.

LANGUAGE, FORTRAN H
MACHINE REQUIREMENTS, IBM 360
PROGRAM SIZE, Approximately 371 source statements
PRICE, Program \$160,00 Documentation \$2,50
PROGRAM NUMBER: MFS-12641

RAM-Reliability Analysis Model

The reliability Analysis Model (RAM) Program is an integrated Systems Design Analysis Program whose primary purpose is to combine the results of various Saturn V analyses into a single effective and comprehensive program. The RAM Program can be readily applied to determine the probability of success for one or more given objectives for any complex system. RAM can be applied to analyze complex transportation systems and traffic control systems and can be used in designing more reliable and safer automobiles. The Reliability Analysis Model Program is also applicable to urban planning, the air pollution problem, weather prediction, the water pollution problem, oceanographic exploration, in determining the effect of the weather on the environment, and in determining the effect of human factors on reliability. The RAM program includes failure mode and effects, criticality and reliability analyses, and some aspects of operations, safety, flight technology, systems, design engineering, and configuration analyses. The unique advantage of this methodology and its associated programs is that the results of all these analyses are fed into a single data bank in terms of impact on mission objectives, so that comparison, correlation, and trade offs may be made between the results of the various analyses. The basic output of the RAM program is the identification of those components that are critical to primary flight mission (no abort), vehicle integrity (no physical destruction of the vehicle), and crew safety. In addition to identifying those components that are critical to a specific objective, this program can rank them in order of importance (probability of causing loss). The program also provides estimates of the probability of primary flight mission success, vehicle integrity, and crew safety - both as an overall number and as a profile with respect to mission time. The criticality determination technique (CD technique) used in conjunction with RAM is a more general method than those currently used. By this new method, criticality numbers can be assigned to components, subsystems, systems, stages, missions and crews for any given failure distribution, such as the exponential, Weibull, Gamma, or truncated normal, where applicable

LANGUAGE. COBOL (100°.)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 18.150 source statements
PRICE: Program \$2.410 00 Documentation \$21.00
PROGRAM NUMBER: MFS-14513

Exact Minimal Path and Minimal Cut Techniques for Determining System Reliability

This is a generalization of a family of techniques for determining by exact methods the probability of success fully operating a system using tree type logical analysis of the configuration of the elements. The system is deemed to be successful if a path of unbroken strings of connected branches corresponding to operating elements and assemblies can be traced from one end of the tree to another. The minimal paths are a subset of the paths and generate all the others; the minimal cuts are the subset of the failure states that generate all the others. The reliability of the system is the probability that at least one path obtains. The unique feature of these techniques is that one can find the system reliability if only either set of minimal states are known. By a recursive process, a system reliability (or unreliability) equation is generated as a function of the reliabilities (unreliabilities) of the elements using the complete set of minimal paths (cuts). The system reliability (unreliability) is formed by substitution into this equation.

LANGUAGE: FORTRAN IV (73%); ASSEMBLER (27%)

MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 1,869 source statements PRICE: Program \$440.00 Documentation \$6.00 PROGRAM NUMBER: MFS-16499

APRDCT - Apportionment/Prediction

This is a general program which utilizes weighting, failure rates, time, reliability equations, and system contractual stage goals to establish phase predicted indices and phase apportioned reliabilities at the component, subsystem and system levels. The weighting factors used in this apportionment reflect. Thurstone Mosteller weightings derived from analyses of components with respect to conditions of use, phase stress conditions, and item capabilities. The phase reliability equations are determined from phase reliability networks by a computer program called MFS-24484.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 4.648 source statements PRICE: Program \$560.00 Documentation \$12.00 PROGRAM NUMBER: MFS-24034

ERSION 3 Reliability Goal Status

The ERSION program is basically a prediction-type program which allows the user to input component level reliability indices and compute overall reliability values at the subsystem, system and unit level. Basically, the program substitutes the input indices in the SCOPE (MFS-16410) generated equation for the subsystem to obtain a subsystem reliability. A set of subsystem level indices are obtained in this manner and are substituted in the associated system SCOPE equation determined by system/subsystem ID code to obtain a system reliability index. Finally, after a complete set of system level reliability indices are generated, numbers are substituted in the SCOPE equation to produce the overall unit reliability. The program allows the user to update a previously generated data set if the only difference between what is needed and what in available from the previous data set is in the compone, t reliabilities. In this case, the user merely c. desithe number of differences on the system or subsystem control card and places the new reliabilities after the basic subsystem set. The component code identifies the component to be changed and the program will apportion the new reliability to the phases of operation in the same proportion as the old values were apportioned. Since phase reliabilities are assumed independent, the overall reliability is the product of the phase reliabilities.

LANGUAGE: FORTRAN IV, H COMPILER
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 4.007 source statements
PRICE: Program \$250.00 Documentation \$12:50
PROGRAM NUMBER: MFS-24121

SCOPE - System for Computing Operational Probability Equations

SCOPE (System for Computing Operational Probability Equations) is a system for determining the probability of success or failure for a given network SCOPE computes from a logical block diagram, success or failure modes, success or failure equations and probability of success or

failure probability indices. SCOPE will merge a pert type path generator with an algorithm for combining failure or success modes to obtain failure or success equations. This allows the user to analyze a system's reliability. The mathematical model for the SCOPE program is based on the Fundamental Law for the Addition of Probabilities and its extension to cases of more than two events. This program could be used in industry to determine the reliability of any large network or system where the functioning of the system is dependent on each step.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,351 source statements
PRICE: Program \$760.00 Documentation \$16.50
PROGRAM NUMBER: MFS-24484

Digital Servo Analyzer

A computer program which enables post test analysis of digitized servomechanism responses on a Hewlett-Packard Model 9100A Desk Computer is offered. The primary function of the program is to compute amplitude and phase angle differences between servomechanism sinusoidal stimuli and response measurements. In addition, the program may be used to perform Harmonic and Fourier analysis of periodic phenomena. This program does not have a program card listing. The documentation and source program are offered only as a complete package.

LANGUAGE: Not Applicable MACHINE REQUIREMENTS: Hewlett-Packard 9100A PROGRAM SIZE: Not Applicable PRICE: \$25 00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MSC-17552

٠,,

Optimization Of Fluid Line Sizes With Pumping Power Penalty

A computer program has been developed to calculate and total the weights for tubing, fluid in the tubing, and weight of a fuel cell power source necessary to power a pump based on flow rate and pressure drop. The larger the tube diameter the greater the weight of tube and fluid weight. For a fixed fluid flow rate, the larger the tube diameter the lower the fluid pressure drop and conse quently the lower the pumping power and weight of electrical power-supply. The greater the flow rule the higher the pressure drop and related pumping power required and weight of power source. Using different stainless steel tubing sizes and flow rates, the systems rates have been calculated for a Shuttle Orbiter water and Frech 21 system. Two different power penalties for pumping power were used in the calculations for all conditions. The optimum water system line size was 5 to 54 inch diameter for a flow rate of 500 lb/hr. The optimum Freon 21 system line size was approximately '* to 's inch diameter for a flow rate of 1800 lb/hr. This program can be used for any fluid system used in any type of application aircraft, spacecraft, trucks, ships, refineries, and chemical processing plants. The weight and the pumping power of the plumbing system can be equated to cost. The line size can then be optimized relative to weight or cost

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS IBM-360

PROGRAM SIZE: Approximately 33 source statements

PRICE: \$25.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing PROGRAM NUMBER: MSC-17930

Reinforced Carbon-Carbon Mass Lors

This package is a series of desk top computer routines for calculating mass loss from Reinforced Carbon Carbon (RCC) materials used in the Space Shuttle missions. The system will calculate and plot mass loss rates and accumulated mass loss for critical locations where temperature and pressure profiles have been determined. The system should be useful in forecasting operating life of materials in high temperature cycling.

LANGUAGE: Instructions and data are entered at the time of processing

MACHINE REQUIREMENTS: Hewlett Packard 9820A

PROGRAM SIZE: Not Applicable

PRICE: \$25.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing

PROGRAM NUMBER: MSC-19494

TRACE - Fault Tree Computer Code Analyzes Large and Complex Systems to Identify and Eliminate Combinations of Maliunctions, Failures, and Hazards

TRACE, a computer simulation technique, has been developed to analyze a fault-tree, estimate the probability of tree failure, and identify the most probable causes. The fault tree concept, originated at Bell Telephone Laboratories, provides a systematic and logical procedure for representing the structure of a system and gives an orderly description of the various combinations of possible cocurrences within a system that can result in a failure. TRACE applies the technique of importance sampling to reduce computer time requirements. The power rule is utilized for the importance sampling. This program performs a Monte Carlo simulation to identify the minimal cutsets and critical paths of a fault tree and to estimate probabilities of fault tree failure. The basic input events to a tree are primary and secondary component failures. The time-to failure for a component is assumed to be a random variable with an exponential distribution. Various types of logic gates are permitted.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM:360
PROGRAM SIZE Approximately 1.637 source statements
PRICE Program \$390.00 Documentation \$12.00 PROGRAM NUMBER: NUC-10402

MATHEMATICS

Includes numerical analysis techniques such as error analysis, function evaluation, numerical integration and differentiation, differential and integral equation solution; combinatorial and discrete mathematics; mathematical programming; mathematical statistics and probability.

Spearman Rho Multiple Rank Order Correlation Program

This program ranks raw data, selects one variable at a time, pairs it with another variable and computes a rank-order correlation. This process is repeated until each variable has been correlated separately with every other variable. Each variable is ranked by assigning the rank of 1.0 to the highest value, 2.0 to the next highest, etc. Ties in the raw data values are adjusted by computing an average rank and assigning that rank to each of the tied data. After all data have been ranked, one set of ranks is subtracted from the other, the differences are squared, and the rankorder correlation cofficient is computed. This procedure may be used (1) for small samples of data, (2) to obtain the relationship between two variables, one or both of which cannot be measured objectively, but which may be ranked subjectively, or (3) when other assumptions for parametric statistics cannot be met. The program will process up to 100 cases for up to 30 variables. No fata point may be larger than 999,998.9 nor less than v.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 77 source statements
PRICE: \$70.00
NOTE: The pure includes the decumentation and a

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: ARC-10165

AESOP-Automated Engineering and Scientific Optimization Program

This program solves a wide range of multivariable parameter optimization problems by providing search techniques for the optimization of non-linear parametrically defined systems. The program has the ability to solve constrained optimization problems involving up to one hundred parameters. Nine search techniques are available for problem solutions; they are: Section-

ing. Adaptive Creeping, Steepest-Descent, Quadratic Search, Davidon's Method, Random Point Search, Random Ray Search, Pattern, and Magnification. The searches may be employed separately or in any sequential combination. The optimization program may be rapidly coupled with a wide class of parameter optimization problems, including systems which have previously been synthesized as digital computer programs.

LANGUAGE: FORTRAN IV (80%): ASSEMBLER (20%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 3,571 source statements
PRICE: Program \$680.00 Documentation \$41.50
PROGRAM NUMBER: ARC-10168

Finding An Extremum of a Bounded Multivariable Function without Determination of the Derivatives

This program searches a local extremum (maximum or minimum) of a function, analytical or computed indirectly, of which it is impossible or difficult to obtain the derivatives. Any inequality constraints on the variables or functions of the variables may be included. The evaluation of the function values is performed in a subroutine given by the user. The constraints are introduced in this subroutine and hence may be nonlinear and can be changed during the search procedure. By a coordinate transformation the search is accomplished in the optimal direction. During the convergence to the optimal point this main direction in the vector-space is continuously adjusted by trials in the remaining secondary directions computed to be orthogonal to the main search direction. By this procedure the algorithm is able to follow accurately shape irregular ridges or deep-curved valleys. The speed of convergence is increased by predicting the near-optimal point long a line with a second order extrapolation-or interpolation method. It is possible to treat multidimensional problems involving variables which may present considerable differences in magnitude, this due to an automatic adjustment of the step-sizes along each direction.

12 14 more many one

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM 360 PROGRAM SIZE: Approximately 172 source statements PRICE: \$120.00 NOTE: The price includes the documentation and a program listing only. The documentation is not seld separately from the program listing. PROGRAM NUMBER: ARC-10577

CONMIN - A Fortran Program for Constrained Function Minimization

CONMIN is a program, in subroutine form, for the solution of linear or non-linear constrained optimization problems. The basic optimization algorithm is the Method of Feasible Directions. The user must provide a main calling program and an external routine to evaluate the objective and constraint functions and to provide gradient information. If analytic gradients of the objective of constraint functions are not available, this information is calculated by finite difference. While the program is intended primarily for efficient solution of constrained croblems, unconstrained function minimization problems may also be solved, and the conjugate direction method of Fletcher and Reeves is used for this purpose. The program can be used without special knowledge of optimization techniques.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Any machine with a
FORTRAN IV compiler
PROGRAM SIZE: Approximately 1,948 source statements
PRICE: Program \$740.00 Documentation \$10.50
PROGRAM NUMBER: ARC-10836

TIDEDA - Time Dependent Data Analyzer

TIDEDA is a computer program for collecting, collating, checking, correcting, and analyzing time dependent data. The program was designed for processing time dependent data in general, and riverflow data in particular, TIDEDA deals with data that is naturally recorded as sequences in time. For example, the daily or seasonal cycles of air temperature. The program has a wide precision range, it is able to estabfish trends over decades and at the same time resolve events that change from second to second. The TIDEDA program is designed with: (1) binary coded files for computational efficiency; (2) a command language for interactive processing; (3) simply identified elements for easy editing; (4) unequal time steps and rating options to allow non-interpretive filing: (5) automatic interpolation linked to the IBM Continuous System Modelling Program for emulating an analog computer. The program assumes that a series of discrete values are joined by straight lines and so may always be graphed as a curve against time. Thus, air temperature can be represented as a line on graph paper which indicates the temperature level as it varies continuously with time. Typically the data requites a single value which describes temperature. for example, but sometimes requires a number of values like the three components of velocity. The

program operates in interactive mode, uses the IBM Continuous System Modelling Program, and Calcomp plotter.

LANGUAGE: FCRIRAN (88%): ASSEMBLER (12%)
MACHINE RECURE MERTS: IBM 370
PROGRAM SIZE: Approximately 9,485 source statements
DISTRIBUTION MEDIA: 9 Track 800 BPI Magnetic Tape
PRICE: Program \$900,00 Documentation \$27,00
PROGRAM NUMBER: COS-02530

SIGPAC - Significance Arithmetic Experimental Package

SIGPAC is a software system which permits a user of Standard FORTRAN to test actual error propagation is numerical calculations. The process is almost completely mechanistic so that, with little human resequencing required or permitted, a "numerical procedure debugging" tool is made available. SIGPAC consists, in effect, of a compiler from FORTRAN source language into an artificial object language in which arithmetic operations produce, in addition to numerical results, a measure of the current significance of each result operand.

The purpose of SIGPAC is to provide to the scientific and engineering users of the IBM 363-95 computing facility a convenient, effective, and quite general means for testing and indicating the accuracy of computer calculations. This work has two primary goals: (a) To permit the testing and localizing of weaknesses within numerical procedures for abnormal error propagation from generated (primarily truncation) errors; and (b) To provide an objective basis for determining when single precision gives adequate significance or when double precision should be used.

LANGUAGE: FORTRAN IV (72%): ASSEMBLER (28%)
MACHINE RI QUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 6,820 source statements
PRICE: Program \$420,00 Documentation \$10.50
PROGRAM NUMBER: GSC-11499

NU'AING - Numeric Integration by Gaussian Quadrature

This program package consists of ten subroutines which apply the Guassian quadrature formula to numerical integration techniques. It has been shown that Gaussian quadrature is superior to ordinary Simpson's Rule for a wide class of functions. An increase in computing speed by a factor from 4.7 to 91 times has been shown for Gaussian quadrature routing over similar Simpson's Rule programs. Since the majority of numerical integrations performed at large computing centers treat far less pathological integrands than those for which Simpson's Rule programs were designed, it is advantageous to use the more rapid Gaussian quadratures whenever possible. How-ever, Simpson's Rule programs provide an excellent means of determining an optimum number for a given accuracy with Gaussian quadratures. The program operates in batch mode and the subroutines are written in both single and double precision.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,760 source statements
PRICE: Program \$440.00 Documentation \$9.00
PROGRAM NUMBER: GSC-11950

PAP - Parametric Analysis Program

PAP provides a systematic approach to Parametric Analysis of systems whose characteristics (dependent variables) are continuous functions of the system parameters (independent variables). It is designed to explore the parameter space of a system using as few system evaluations as possible. This is achieved by: (1) Program design features which reduce the number of approaches to the computer required to obtain a given degree of coverage of the parameter space; (2) Algorithms specifically designed to minimize the number of system evaluations; (3) Extensive use of interpolation and extrapolation; and (4) The provision of a flexible contour plotting capability. The approach taken by PAP is to apply n 2 to is the number of system parameters) constraints to the parameter space for fixed values of the remaining two parameters. Determine solutions to this nonlinear constraint problem and map the solutions found to the points of a grid determined by the domains of the two parameters previously fixed. This gives rise to a number of functions of two variables defined at discrete points which represent the behavior of the constrained system, PAP provides an interpolation scheme to generate contours of these functions and a flexible plotting capability so that they may be displayed in various combinations.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM 3IZE: Approximately 2,500 source statement:
PRICE: Program \$310.00 Documentation \$9.00
PROGRAM NUMBER: HQN-10649

Bellcomm's Approximation Library

This is a package of six subroutines designed to calculate the value of various functions. The subroutines and their functions are: (1) BARN-random number generator, (2) CISI-evaluates sine and cosine integrals, (3) ELIP-computes complete and incomplete elliptic integrals, (4) NEWTON-finds the real root of some real-valued functions of a single real variable by the Newton-Raphson method, and (5 & 6) NUMBERS and RMIDPT- these subjoutines compute the numerical solutions to a system of simultaneous ordinary differential equations, NUMBERS uses a fourth order variable step size predictor corrector integration, RMIDPT uses an extension of the trapezoidal rule to approximate the integral of a function and incorporate Euler's revised method to enable it to solve differential equation.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 1,409 source statements
DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape
PRICE: Program \$260.00 Documentation \$4.50
PROGRAM NUMBER: HQN-10735

Bellcomm Linear Algebra Library

This library of programs is Bellcomm's Linear Algebra Library. The programs are on magnetic tape and consist of eight separate files. The files have the foltowing functions: File #1-EGNVEC-The complete eigenvalue problem for general real matrices: File #2 "GAUSS - Solution of a system of linear equations; File #3-HESH Program - Hessenberg-Householder Reduction, TRNVEC -Vector transformation; File #4 -- CHCLESKY-- Used Cholesky (or square root method) for computing and inverting matrices; File #5--MAP "Find some or all the frequencies and orthogonal mode shapes of any linear discrete system which is governed by a generalized eigenvalue equation; File #6- QR.- Egenvalues and eigenvectors of symmetric matrices; file #7-SIRLIG- Used for the solution of a linear generalized real symmetric positive definite eigenproblem; and File #8 -SGEIG - Used for solving the real symmetric alegbraic eigenproblem. The documentation for the programs consists of brief write-ups and or abstracts giving the function and uses of the reutine(s) within the various files.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108, EXEC-VIII
PROGRAM SIZE: Approximately 10,000 source statements
PRICE: Program \$600.00 Documentation \$14.50
PROGRAM NUMBER: HQN-10738

LPII - LaGrange Three Point Interpolation Computer Program

This program generates equally incremented interpolated data, using the LaGrange interpolation formula for equal or unequal intervals of data, Input to the program consists of the input data set and the following parameters: number of functions to be interpolated, the first and last arguments to be interpolated, and the output options. The input data set may be on cards or tape; the output data set and the interpolated factor may be on tape, cards, and or the printer. Each pend of the input data set consists of an argument followed by as many as 19 functions to be interpolated. Three data points are used to calculate each interpolated point. The points to be interpolated are always maintained between the first and second of three data points, except for the extrapolated regions. Extrapolation before the data set may be forced by setting the first argument to be interpolated less than the first argument of the data. Extrapolation beyond the available data may be forced by setting the last argument to be interpolated greater than the last argument of the data.

EANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: GE-635 PROGRAM SIZE: Approximately 115 source statements PRICE: \$55.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: KSC-10418 FORTRAN IV Program for Symbolic Solution of Up to 20 Simultaneous Equations

. This program is basically a symbolic manipulator which provides a means for obtaining an algebraic

solution to a set of up to 20 simultaneous equations. The algebraic (as opposed to the numeric) solution is useful in understanding the influence of the coefficients on the solution and in determining formulas which can be used in further analyses. In general, the program operates by reading in the linear equations in matrix form as the matrix equation $A_1 \mid X_1 = B_1^{\top} \mid Y_1^{\top}$ where the X's are the dependent variables, the Y's are the independent variables, and the A's and B's are the constant cofficients of the equations. Also read in is the list of X solutions desired since it is not usually required to solve for all X's. The program then operates on the matrices to develop the matrix equation $A_1 \mid X_1 \mid B_1 \mid Y_1^{\top}$ Juring which operation the particular X solutions requested are obtained.

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094 7044 DCS
PROGRAM SIZE: Approximately 404 source statements
PRICE: Program \$290.00 Documentation \$2.50
PROGRAM NUMBER: LEV-10439

MATAR - Conversational Approach to Matrix Calculations

This is a computer program which enables users to do matrix computations without knowledge of computers or programming languages. Potential users can easily learn the command language recognized by the program. The program, called MATAR, interacts with users in a conversational manner. It is now running under a time-sharing system. MATAR provides for simple input output of matrices, matrix arithmetic, and several other operations. These include formations of the transpose, inverse, determinant, and eigenvalues and exponentiation. The program can issue specific complaints about input it cannot process. For example, if the user tries to use a matrix not previously defined, the program tells him that the matrix is unknown and therefore that particular calculation must be cancelled. The user can promptly see and rectify his errors.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,338 source statements
PRICE: Program \$440.00 Documentation \$3.50
PROGRAM NUMBER: LEW-10830

Computer Program for Spline Fit Curves

The spline fit curve is a convenient method for fitting a curve through a given set of points. This program will calculate the spline fit curve, with function values, first and second derivatives, and curvative at any desired interpolated points. If a set of function values corresponding to a set of arguments is given, there are several ways a curve can be fitted through these values so as to approximate the original function with these values. The classical way is by an nth degree polynomial for n-1 points. However, this may not be satisfactory for a large number of points, Other methods include Least Sou ites and the Four-Point Lagrangian interpolation. But these methods have short comings over come by the spline fit.

or piecewise cubic fit method. The spline fit curve gives a simple method of determining an approximating analytical curve which can be used in place of the original curve for interpolation, determining first and second derivatives, curvature, or integration.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE: Approximately 85 source statements
PRICE: \$80.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: LEW-10317

RAPIER - FORTRAN IV Program for Multiple Linear Regression Analysis Providing Internally Evaluated Remodeling

RAPIER is a very flexible, easy to use, sophisticated multiple linear regression program; its major asset is its comprehensiveness of calculations and options. With the aid of a few control cards, the program can be used readily for a wide range of applications which can vary from a simple least-squares curve-fitting problem to a complete regression analysis. It can provide the variance-covariance matrix of independent variables, regression coefficients, individual t-statistics with their significance levels, analysis of variance tables for significance of regression, special useage of replicated d. ta to estimate the error due to lack of-fit, any one of three pooling precedures which may be used to estimate the error variance, tests for normality of distribution of the residuals, weighted regression, and the use of more than one dependent variable. The mathematical analysis of the computations and their reliability is aided further by the option of obtaining an eigenvector decomposition of both the variance-covariance matrix and the correlation matrix of the independent variables. The program also provides an option to perform a backward rejection regression at any given level or significance. Despite its sophistication, RAPIER is relatively easy to use, but it presupposes that the user has at least a basic knowledge and or experience in the application of statistical techniques.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IEM-7094 11 7044 DCS
under IBSXS Version 13 using ALTIO
PROGRAM SIZE: Approximately 2,217 source statements
PRICE: Program \$370.00 Documentation \$10.50
PROGRAM NUMBER: LEW-11062

GIPTRAN - General Input Probability Translator

The program package entitled GIPTRAN is actually two programs, (GIPTRAN and STORM) which provide mathematical foutnes for statistical analysis in one computer run. The GIPTRAN program generates a FORTRAN deck from a higher level language (called GIPTRAN). The data-is then treated by STORM to give frequency distribution; pi, bability distribution; cumulative probability distribution; sample size; mean value; stindard deviation; sample range; goodness-of-fit tests; arithmetic combinations of probability dis-

tributions; and tolerance intervals. The GIPTRAN language is documented in the program package but a knowledge of FORTRAN is a prerequisite to understanding this language. STORM (Statistical Operations on Random Measurements) computes statistics and probabilities (mentioned above) of n independent continuous random variables. The programs are applicable only when the size of each input sample is large; the accuracy of the results is seriously eroded when any of the input bodies of data has less than 100 observations. A maximum of 3000 sample measurements for any one random variable may be input. The package is designed to be used as a probabilistic approach to the solution of engineering problems. It was developed to compute statistical parameters (random variables) which are simple functions of many other input parameters (also random variables). The most important feature of STORM is the ability to combine independent continuous random variables in basic arithmetic operations. The program can solve $f=(a \cdot b) \cdot c \cdot d$ where a, b, c and d are independent, continuous random variables and f is continuous random variable dependent upon a, b, c and d. It accomplishes this by classifying input data into intervals and then computing probabilities corresponding to the interval midpoints.

MACHINE REQUIREMENTS: CDC 6000 Series (with FORTRAN RUN compiler)
PROGRAM SIZE: Approximately 3,860 source statements
PRICE: Program \$820.00 Documentation \$17.00
PROGRAM NUMBER: LEV-11452

LANGUAGE: FORTRAN (98%); COMPASS (2%)

FITLOS—FORTRAN Program for Fitting Low-Order Polynomial Splines by the Method of Least Squares

FITLOS is a computer program which implements a new curvefitte technique. This technique consists of (1) dividing the set of data points into subsets, (2) fitting a polynomial of degree two or three to each subset, and (3) smoothing the total curve by assuring that the first derivatives in the case of second degree polynomials, or the first and second derivatives in the case of third degree polynomials, are equal at the break points of each segment of the curve. These continuity constraints are imposed by use of Lagrangian multipliers. This method can be useful in cases (1) where the data contains random errors such that the application of any known methods of interpolation would lead to undesirable errors, (2) where the use of polynomials of sufficiently high degree, to provide formally small errors, would result in computation difficulty because of the occurrence of large coefficients of opposite signs, and (3) where a reasonable initial value guess is desired for some iterative computation. The main program, FITLOS, reads the input data, calls the appropriate subroutines for the curve-fitting, calculates a statistical analysis, and writes the output data. The modular structure of this program allows a potential user to incorporate this procedure into another computer program since the curve-fitting requires only three subroutines.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7034 7044 DCS
PROGRAM SIZE: Approximately 1,765 source statements
PRICE: Program \$480.00 Documentation \$11.50
PROGRAM NUMBER: LEW-11651

NEWRAP - An Improved Multiple Linear Regression and Data Analysis Computer Program

A digital computer program (NEWRAP) has been developed which can be used with ease to perform extensive regression analyses or a simple leastsquares curve fit. The major value of the program is the comprehensiveness of its calculations and options. NEWRAP computes the variance-covariance matrix of the independent variables, regression coefficients, tstatistics for individual tests, and analysis of variance tables for overall testing of regression. There is a provision for a choice of three strategies for the variance estimate to be used in computing t-statistics. Also, more than one set of responses of dependent variables can be analyzed for the same set of independent variables. A backward rejection option method based on the first dependent variable may be used to delete nonsignificant terms from the model. In this case, a critical significance level is supplied as input. The least significant independent variable is deleted and the regression recomputed. This process is repeated until all remaining variables have significantly non-zero coefficients. The NEWRAP program uses the triangular form of symmetric matrices throughout, It allows also for the use of weighted regression, computation of predicted values at any combination of independent variables, a table of residuals, and plots of residuals. By use of CRESPIT, a separate program, a preregression analysis may be performed which may aid in the choice of model to use the NEWRAP. This program accepts the same raw data in the same format and computes the variancecovariance matrix and correlation matrix of all the variables and an eigenvector decomposition of the variance-covariance matrix corresponding to the independent variables. Microfilm plots are then printed of specified pairs of variables. Punched output of residuals and predicted values from NEWRAP can also be used for more complicated residual plots than the direct use of the plotting option NEWRAP permits. When a quadratic response function has been estimated (as for example in optimum-seeking experimentation) CREDUC, another separate program, may be used to obtain all information necessary for a canonical analysis of the function. The three programs together provide a useful data analysis package that can be applied to a large variety of common research and development situations.

LANGUAGE: FORTGAN IV
MACHINE REQUIREMENTS: IBM-7094 7044
PROGRAM SIZE: Approximately 2,726 source statements
PRICE: Program \$460.00 Documentation \$11.00
PROGRAM NUMBER: LEW-11842

AMINT-Adams Moulton Integration Subroutine

This subroutine will numerically integrate a set of n simultaneous first order ordinary differential equa-

tions, by either the Adams-Moulton method of the fourth order Runge-Kutta method. It has been checked against several known solutions, and in all cases the errors were approximately equal to their expected values. There were no indications that round-off errors accumulate rapidly. This subroutine offers the user an option of using one of the following methods to solve first-order differential equations: 1. A fourth-order Runge-Kutta method with a fixed step size, 2. Adams-Moulton method with a variable step size, and 3. Adams-Moulton method with a fixed step size.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 154 source statements
PRICE: \$70.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MFS-00465

Cutlier Technique Program

This program identifies questionable values in an array of numbers. The program is based on a method which is called the "Full Normal Plot". A description follows: (1) let a, , be a typical value for the ith ordered observation in a sample of size n from a unit normal distribution. The choice $a_1 = GUA = 1 - \frac{30-1}{2}$ where P=GUA (y) is the cumulative normal, is an adequate approximation to what is claimed to be optimum and is easy to compute. (2) Order the sample of size n to be examined such that y_1, y_2, \dots, y_n . Let y' be the median of the y's. (3) For the top third and the bottom third of the ordered array, compute the quantity $Z_1 = (y_1 - y') a_1 = 1$ The i's with (1/3)n < i < 1(1 3) (2n) are from the formation of Zi's both because the small values of a, , promote instability and because Zi's for such i's seem unrevealing, (4) Approximately (1 3) (2n) of the Z values have been computed. Calculate the median, Z', of the Z's. (5) Special attention should be given to Z values for which both $(y_1-y')>AZ'$ and $Z_1>BZ'$ where A and B are prechosen constant values. (6) If some or several Z₁ values are selected from the above, the Zj's with j more extreme than a selected i also deserve special attention. This

MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 139 source statements
PRICE: \$45.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MFS-01128

is particularly true if the n is small.

LANGUAGE: FORTRAN IV

Calculation of Eigenvalues and Eigenvectors of Arbitrary Matrices

This program uses a modification of the Greenstadt method to calculate the eigenvalues and eigenvectors of an arbitrary complex material. Basically, the matrix is reduced to upper triangular form. Elements in the lower triangle (called the pivot elements) are driven

to zero through the application of a sequence of unitary transformations. The sequence of operations upon the set of pivot elements is called a pass. The algorithm continues until a specified maximum number of passes has been made or until the average modulus of the set of pivot elements has been reduced to a particular value. The maximum order of the input matrix is 40. The triangularized matrix (labeled "Eigenvalue Matrix") is output in two parts, the real part and the imaginary part. The eigenvalues appear on the main diagonal, real part and imaginary part. The vector matrix of the triangularized system (in similar format) follows. Finally, the eigenvector matrix of the original system is output.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 298 source statements
PRICE: Program \$140.00 Documentation \$4.00
PROGRAM NUMBER: MFS-02398

Point Transformation-Orthographic to Perspective, FORTRAN H Version for 360 System Use

This is a general purpose subroutine to transform orthographic points to perspective points, and present a perspective picture of an object described by orthographic dimensions. Transformation is performed by means of algebraic formulas. In addition to the coordinates to be transformed, the user specifies in the call statement the viewing angle from which the view is to be taken, the distance from which the view is to be taken, the height from which the view is to be taken, and the projection length for the perspective points.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 54 source statements
PRICE: \$70.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MFS-02486

Solution of Large Sets of Simultaneous Linear Equa-

A digital computer program has been written to solve large systems of simultaneous, linear equations having banded, symmetric matrices. The problems that are considered by the program are limited to these which have a bandwidth that is less than the number of equations. The core storage needed by the program is independent of the number of equations, and hence, the program is not limited directly by the order of the matrix. Flexibility in applying the program is realized by variably dimensioned arrays and by user selection of auxiliary storage devices. As many as 10,000 equations have been solved in tacke minutes with this program. Results accurate to nine significant figures were obtained. Subroutines, callable from a FORTRAN program, to read a FORTRAN-produced tape backwards are a feature of the program that could be used elsewhere to reduce execution time.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360-65
PROGRAM SIZE: Approximately 558 source statements
PRICE: Program \$160.00 Documentation \$3.00
PROGRAM NUMBER: MFS-12347

RKADAM - Subroutine to Solve Differential Equations

Subroutine RKADAM gives a stepwise solution to a system of N first order differential equations of the form, $y_1'...f_1(x_1y_1,y_...,y_n)$, i=1 to N. The user has the option of selecting one of the following methods to perform the integration: (a) Single step 4th order Runge-Kutta method with fixed increment; (b) Adams method with third differences and fixed increments: and (c) Adams-Moulton method with third differences and variable increments.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 225 source statements
PRICE: \$90.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MFS-12981

DENORD - Solution of Differential Equations Using the Nordsieck Method

This subroutine solves an Nth order system of first order ordinary differential equations using the method described in the following: "On Numerical Integration of Ordinary Differential Equations", Arnold Nordsieck, Mathematics of Computation 16 (1962), pp. 22-49. This method, which is stable under all circumstances, incorporates automatic starting with automatic choice and revision of integration step size. In addition, the amount of computation for a specified accuracy is approximately minimized. All arithmetic calculations are performed in double precision. This technique may be applied to any system of differential equations with derivatives which are either continuous or piecewise continuous with finite jumps.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 204 source statements
PRICE: \$90.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.

FORIER - Subroutines for Lens Design Program

PROGRAM NUMBER: MFS-13122

This subroutine computes the coefficients [a] and b. of the real Fourier series for a given tabulated real function f. The series is then evaluated for real arguments. The method of calculation, based on a real Fourier analysis, is described in two textbooks referenced in the program documentation. All arithmetic calculations are performed in double precision, and the calling sequence requires double precision arguments. The function to be approximated is assumed to be periodic with respect to the given inter-

val, and the given set of functional values is assumed to be equally spaced with respect to the given interval. It is assumed that the initial functional value is located at the left-most point of the interval.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 123 sou/ce statements
PRICE: \$90.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MFS-18565

Method for Manlinear Exponential Regression Analysis

The investigation of physical processes frequently require the use of models that simulate or describe the processes. A model is often chosen so that certain variables interact in the model according to physical theories associated with the particular process. A model equation contains identified independent variables and unknown parameters. Regression analysis is the statistical tool used to determine the unknown parameters which provide an analytical representation of the experimental data. The general procedure in regression analysis is to take partial derivatives of a specific model-dependent minimizing function. These partial derivatives are taken with respect to each of the unknown model parameters. If the set of equations obtained by setting these partial derivatives equal to zero can be solved by the usual algebraic methods, the fitting or analytical representation is accomplished. However, if these equations are transcendental in one or more of the unknown parameters, they cannot be solved by the usual algebraic methods. The processes of particular interest in this program are those that can be described by decaying exponential forms. A mathematical model that contains more than one exponential term results in a set of transcendental normal equations if conventional forms of regression analysis are used. Thus, one usually resorts to iterative methods that require initial estimates for the parameters. The method used in this program is the least squares procedure, whereby, the nonlinear problem is linearized by expanding in a Taylor series. In the iterative method, one develops a starting nominal guess for the model parameters, A correction matrix is derived and then applied to the nominal guess to produce an improved set of model parameters. This procedure is continued until some predetermined criterion is satisfied. The number of iterations necessary for convergence is closely relited to this criterion, the initial estimates, and the form of exponential model. Two general types of exponential model programs were developed to implement the theory for exponential regression analysis. One concerns a single exponential and the sum of exponentials without a constant, and the other concerns the sum of exponentials with a constant in cluded. Each program contains double-precision capability and the SC-4020 plotting procedures.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108, SC-4020
Plotter

PROCOAM SIZE: Approximately 2,159 source statements
PRICE: Program \$510.00 Documentation \$10.00
PROGRAM NUMBER: MFS-21955

Selection of Approximating Functions for Tabulated Numerical Data

This computer program selects, from a list of candidate functions, the approximating functions and associated coefficients which result in the "best curve fit" of a given set of numerical data. The approach used in the development of this program yields several advantages over other "best fit" programs. Some advantages offered by this approach are that multivariable approximations can be performed and there is a degree of flexibility with respect to the type of approximation used. The program is designed to choose the "best" terms to be used in the approximation from an arbitrary list of possible terms so that little knowledge of the proper approximating form is required. Elementary matrix operations and vector methods are the techniques used to determine the recursion relations which are used in determining the coefficients of approximating functions. This reduces the computer execution time of the program. This program is missing three minor subroutines that must be supplied by the purchaser, if a computer plot is needed.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 760 source statements
PRICE: Program \$340.00 Documentation \$17.50
PROGRAM NUMBER: MFS-22135

A Computer Program for Standard Statistical Distributions

A computer program that will provide efficient procedures for determining theoretical statistical models for empirical data is presented as three options, A, B, and C. Option A, a theoretical approach, is the Pearson System of frequency distributions developed by Karl Pearson. Option A also provides sample statistics including central and non-central moments, appropriate variances and standard errors of theoretical parameters, and the cumulative probability function. Options B and C of the program provide a straightforward empirical approach to the problem. Known standard statistical distributions are presented as prospective models for the sample input. Option B includes continuous distributions, and option C includes discrete models. Statistical tests for "goodness of fit" are included for making objective decisions in regard to rejection or non-rejection of hypothetical models selected.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360, UNIVAC 1100
series
PROGRAM SIZE: Approximately 846 source statements
PRICE: Program \$410.00 Documentation \$11.50
PROGRAM NUMBER: MFS-22994 (IBM Vers.), MFS21456 (UNIVAC Vers.)

TEMPO-Technique For Evaluating Multiple Probability Occurrences

This program was written to automate a statistical process by which subjective responses in the form of paired comparisons are quantitatively evaluated to produce relative probabilities. The program is useful in any analysis which requires a ranking to be established for a set of elements for which there is little available data. The program has been extensively used in prediction and apportionment for the S-II Stage of the Saturn Rocket. To illustrate the use of this program, suppose three systems must be ranked as to their relative probability of success and that previous data is not available on these systems since they are in the preliminary design phase. To get the best possible ranking of these systems, rating matrices are prepared according to prescribed instructions. The program then averages all the rating matrix entries and every entry is transformed into a Normalized Preference Matrix. This transformation makes all of the entries positive and less than one, hence they can be associated with a probability distribution.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM-360 65
PROGRAM SIZE: Approximately 250 source statements
PRICE: \$25.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MFS-24100

Polynomial Matrix Equation Solver

Given the matrices A and C whose elements are polynomials or order 2 or less. A being N by N and C being N by M, this program obtains the inverse of A in terms of A- adjoint and the determinant, P. It then obtains the solution matrix, X, of the matrix equation Ax=C. If desired, it obtains any specified linear combination of the elements of X. In addition, all roots of the polynomials which are the determinant and the numerators of selected elements of X are printed out in a manner to highlight frequency and damping factors. For matrix inversion, Leverrier's method is used. In this inversion, software-extended precision equivalent to about 31 decimals is used, afforded by the Q-Precision System supplied by C. L. Lawson of JPL. Eleswhere, hardware double-precision is used freely. This mixture is adequate to avoid confusing spruious roots which are without physical significance. N is limited to 14 cr less. Unless N is 12 or less. M is limited to 1. This program can be used in control problems where the Laplace transform is applied to a set of simultaneous algebraic equations with polynomials as coefficients. The solution of this system will yield the system transfer functions as elements of the inverse matrix, and also the Laplace transform of the system response to a given forcing function. The same mathematical structure is found in other applications such as the analysis and synthesis of networks; feedback circuits, and design of digital band pass filters.

LANGUAGE: FORTRAN V (95%): SLEUTH (9%)
MACHINE REQUIREMENTS: UNIVAC-1108

PROGRAM SIZE: Approximately 1,828 source statements
PRICE: Program \$260.00 Documentation \$9.00
PROGRAM NUMBER: MSC-14094

UHELP - University of Houston Easy Linear Programming System

There are a number of linear programming routines available to the computer user. However, to use these standard routines effectively, the user must have a basic knowledge of computer programming and computer vocabulary. The formats in which data has to be punched for some of these routines are quite complex. Moreover, the output can be rather confusing to the occasional user. Some of the routines available are coded in more than one language, which presents a problem in implementation. Alteration of these existing routines is practically impossible even for an experienced programmer. To overcome these difficulties an interpretive type of language is presented with the acronym UHELP (University of Houston Easy Linear Programming). The language enables the user to input his data in the same form as he would write his linear programming problem on paper. The interpreter is coded in FORTRAN IV and hence can easily be converted to almost any computer system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 1,267 source statements
PRICE: Program \$200.00 Documentation \$6.00
PROGRAM NUMBER: MSC-14147

Algorithm for Matrix Bandwidth Reduction

For a great many structural problems, particularly using the finite element method, the mathematical model that must be solved is a set of linear simultaneous equations. Among the fastest methods for solving this class of mathematical problems are the elimination techniques which involve two main steps: (1) decomposition and (2) backsubstitution. The amount of time required to perform the technique is a function of the size and the bandwidth of the coefficient matrix. For a matrix of a given size, the time required to solve the system is directly proportional to the square of the bandwidth, Bandwidth is defined as the maximum size (in terms of column indices) between the main diagonal and any non-zero element in that row. A computer program was developed to solve a system of simultaneous linear equations by the bandwidth reduction method. Bandwidth reduction is needed in order to reduce the time and cost of computing answers for systems of equations. For example, a reduction in bandwidth of 50% represents a reduction in solution time of 75%. The method used for the present program is a simple and straightforward procedure which systematically moves rows closer together that are far apart and coupled. A comparison of this bandwidth reduction method with existing algorithms is presented in the documentation. Also results obtained by using this method on ten different topologies are given.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 138 source statements
PRICE: \$85.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separately from the program listing.
PROGRAM NUMBER: MSC-17550

Addition Cor. clution Computer Program for Cost Risk Analysis

In cost risk studies probability density functions are determined judgmentally by subsystem engineers and cost analysts working together. These functions express probability of cost for subsystem elements. The subsystem functions then have to be combined to determine a total system cost probability function. In many cases the addition convolution theorem is applicable, which allows the determination of density functions for sums of random variables through evaluation of a convolution integral. The present computer program performs this integration numerically, two functions at a time successively, from input density functions defined by sets of coordinate pairs. The program was written to provide a simpler, faster, and less expensive working tool for risk studies than the programs which use Beta functions.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360 PROGRAM SIZE: Approximately 52 source statements PRICE: \$95.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: MSC-19078

Routines for 3-D Vector Computations

Frequently used 3-dimensional vector operations have been programmed, to serve as a mathematical convenience by providing a coordinated set of reutines normally used in various sequential order. The solution of 3 dimensional geometric problems which have been mainly solved graphically in the past can now be programmed for computers.

LANGUAGE: N A
MACHINE REQUIREMENTS: Hewlett-Packard 9100A
PROGRAM SIZE: Not Applicable
PRICE: \$55.00
NOTE: The price includes the documentation and a
program listing only. The documentation is not sold
separate from the program listing.
PROGRAM NUMBER: MSC-19289

Statistical Table Value Estimation (t and Chi Square)

This package of desk-top computer procedures estimates values (probabilities and percentage points) for two frequently used statistical tables, t and X^2 distributions, using the standardized normal distribution table.

LANGUAGE: Instructions and data are entered at the time of processing.

MACHINE REQUIREMENTS: Compucorp 145E PROGRAM SIZE: Not Applicable PRICE: \$25.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: MSC-19475

VERGE - Computer Subroutine to Accelerate the Convergence of Iterative Processes

VERGE is a general-purpose FORTRAN IV routine which is designed to ac elerate the convergence of iterative processes and can be used to solve the many equations encountered in the numerical solution of engineering problems which do not permit explicit solutions for certain variables. Iteration is often the only effective means of solving non-linear algebraic and transcendental equations. Therefore, the general class of problems which is of interest is that which may be written in the form x=f(x). The routine is based on the convergence algorithm of Wegstein. The method accelerates the rate of convergence if the iteration converges, and it induces convergence if the basic iteration process tends to diverge. The convergence is quadratic which means that asymptomatically the number of correct decimal places is doubled at each step. The method is analogous to the graphical procedure of finding the intersection of curves y=x and y=f(x), except that the process is automated. Iteration is started with a guess, from which the subroutine derives an improved estimate, and the process continues until the difference between successive estimates, and the process continues until the difference between successive estimates is arbitrarily small. In addition, underflow protection is provided so a search for roots close to the origin will not violate machine limits.

LANGUAGE: CDC FORTRAN IV MACHINE REQUIREMENTS: CDC 6000 Series PROGRAM SIZE: Approximately 70 source statements PRICE: \$95.00 NOTE: The price includes the documentation and a

program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: NPO-10614

SPLINT - Parabolic Spline Interpolation Subroutine

The SPLINT program performs interpolation and differentiation using the parabolic spline. This spline fit, while not as accurate as the cubic or higher order splines, can be generated by a closed-form expression. The method is analytically equivalent to taking four consecutive tabular points and fitting a parabola through the first three points and a parabola through the last three. The parabolic spline between the two middle points of the set is determined by linearly interpolating between the two parabolas. Continuity of the first derivative of the fitted curve is preserved. A new search scheme was devised to permit the use of tabular data where the independent variable is either inenotonically increasing or decreasing. This feature allows the subroutine to handle inverse interpolation directly, with the restriction that Y=F (x) and the inverse operation X=G (y) are both single valued. Also, in the interest of generality, a special indexing scheme is used to facilitate multidimensional interpolation. Endpoints and extrapolations are handled by letting the first three tabular points, or the last three, determine a parabola which defines the fit at the extremities of the table.

LANGUAGE: CDC FORTRAN IV MACHINE REQUIREMENTS: CDC-6000 Series PROGRAM SIZE: Approximately 249 source statements PRICE: \$55.00 NOTE: The price includes the documentation and the

program listing only. The documentation is not sold separately from the program.

PROGRAM NUMBER: NPO-10786

Random Number Generator

This package consists of six routines which perform random number generations from various types of populations. UNIFRM generates floating point numbers from a uniformly distributed population with a sample space defined by the open interval (0, 1). The routine uses a multiplicative, congruential pseudorandom number generator. GAUSS, on the other hand, uses Bell's algorithm which is a modification of the method of Box and Muller to generate floating point numbers from a normally distributed population with a zero mean and unit variance NPOISN uses Snow's algorithm to generate integers from a population which has a Poisson distribution. The algorithm of Ralston and Will is used by EXPONT to generate floating point numbers from a population which satisfied an exponential distribution on the interval). If the population has a Rayleigh distribution, RAYLEI is used to generate floating point numbers. Finally, GVEC generates random vectors from a multivariate normal population with specified mean vector and variance-covariance matrix.

LANGUAGE: FORTRAN V (91.7%); SLEUTH (8.3%) MACHINE REQUIREMENTS: UNIVAC 1103, EXEC VIII PROGRAM SIZE: Approximately 451 source statements PRICE: \$75.00

NOTE: The price includes the documentation and a program fisting only. The documentation is not sold separately from the program listing. PROGRAM NUMEER: NPO-11528

RFT1 · One · Dimensional Real Fourier Transform

This subroutine computes one-dimensional Fourier transforms for real data using the Cooley-Tukey Fast Fourier Transform (FFT). Applications include: (1) Finite Fourier analysis, (2) The calculation of Fourier transforms, (3) Calculating convolutions and lagged products (e.g. digital filtering), (4) The calculation of power spectra, and (5) The inversion of Laplace trans-

LANGUAGE: FORTRAN V MACHINE REQUIREMENTS: UNIVAC-1108 PROGRAM SIZE: Approximately 456 source statements PRICE: Program \$349.00 Documentation \$6.50 PROGRAM NUMBER: NPO-11649

CFT - Multi-Dimensional Complex Fourier Transform

This subroutine computes multi-dimensional complex Fourier transforms in up to six dimensions using the Cooley-Tukey Fast Fourier Transform (FFT). Applications of this program include: (1) Finite Fourier analysis, (2) The calculation of Fourier transforms, (3) Calculating convolutions and lagged products (e.g. digital filtering), (4) The calculation of power spectra, and (5) The inversion of Laplace transforms.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 416 source statements
PRICE: Program \$340.00 Documentation \$5.50
PROGRAM NUMBER: NPO-11651

ROMBS - Modified Single Precision Romberg Quadrature Subroutine

This program package consists of two subroutines for evaluation of a single integral and a group of three subroutines for the evaluation of multiple integrals. ROMBD and ROMBS are double and single precision subroutines respectively for numerical quadrature, using a modified Romberg procedure with a variable step size. This package also contains subroutines RMB1, RMB2, and RMB3 for the evaluation of multiple integrals. ROMBS is used as the basic integration technique. These routines represent a "state of the art" in their field. They have been thoroughly tested and found to be equal or better than any comparable routines. The programs have been compared to SQUANK of J. Lyness (see ACM Journal, Volume 16, July, 1969, "Notes on the Adaptive Simpson Quadrature Routine") and found to be more reliable and better able to solve a larger class of problems. Although these routines are designed to serve as a library "standard" to evaluate most definite integrals. it is necessary to realize that with singularities and certain discontinuities in the integrand, Gaussian quadrature or other methods may be more appropriate.

LANGUAGE: FOR RAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 1,213 source statements
PRICE: Program \$260.00
PROGRAM NUMBER: NPO-11718

STURM-Eigenvalue Routine by Sturm Sequence Method

This computer program has been generated for the efficient solution of certain broad classes of eigenvalue problems. Extensive applications of the procedure are envisaged in the analysis of many engineering problems such as natural frequency and stability analysis of practical structures discretized by the finite element technique. The procedure used in this program fully exploits the banded nature of the associated matrices and further enables the user to compute either all the roots or any specific ones as desired. Thus once the range of values for the roots are specified, the routine computes the first required

NR roots lying within the range. The routine also computes repeated roots as well as the eigenvectors. Storage requirements are modest, since only one working store of moderate dimension is needed for the solution. Further special storage options enable storing mostly nonzero elements only of the associated main matrix of the eigenvalue problem.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 867 source statements
PRICE: Program \$430.00 Documentation \$2.50
PROGRAM NUMBER: NPO-11805

Reliability Computation from Reliability Block Diagrams

This program package consists of a probability calculation program used to calculate the probability of system success from an arbitrary reliability block diagram. The class of reliability block diagrams that can be handled include any active standby combination of redundancy, and the computations include the effects of dormancy and switching in any standby redundancy. The program is based on an algorithm which extends probability tree usefulness to standby systems. Four factors to be considered in calculations of this type are active block redundancy, standby block redundancy, partial redundancy and the presence of equivalent blocks in the diagram. The probability of successful operation for a system involving active redundancy is found using the probability tree method. The principle that is used in computing standby redundancy is simple but difficulty occurs in applying the principle to complex circuits; methods and equations are presented in the program documentation. Partial redundancy is handled by manually setting up the problem in terms of equivalent blocks. Equivalent blocks occur when the same piece of physical hardware appears more than once in the reliability block diagram. When this happens, the program assumes that if the block worked in one occurrence, it will work in the other and vice versa. To accommodate storage capacity (on the UNIVAC 1103), the following program limitations exist: (1) maximum of 50 blocks to a block diagram, (2) maximum of 200 success paths, (3) there can only be one output block, and (4) maximum of 14 inputs and 14 outputs per block (The first three restrictions can be overcome by grouping blocks and or success paths; by routing output blocks through one final success block). The program is written to be used on a UNIVAC 1108 timesharing system with 65K core storage and a UNIVAC 1103 FORTRAN V compiler. The program can be run in either batch or interactive mode.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series
EXEC 8
PROGRAM SIZE: Approximately 4,756 source statements
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR
Formatted Tape
PRICE: Program \$950.00 Documentation \$6.50
PROGRAM NUMBER: NPO-13304

SPIN-Spining Structures Eigenproblem Solver

This computer program may be conveniently utilized for the accurate solution of a wide range of practical eigenvalue problems. Important applications of the present work are envisaged in the natural frequency analysis of spinning structures discretized by the finite element technique, and in the determination of transfer functions associated with the dynamic blocks of control systems of spacecraft utilizing gas jets or reaction wheels for attitude control, as well as of spin-stabilized and dual-spin-stabilized satellites. The validity of the Sturm sequence property is first established for the related matrix formulation involv-

ing Hermitian and real symmetric, positive-definite matrices, both being usually of highly banded configuration. A numerically stable algorithm based on the Sturm sequence method is then developed which fully exploits the banded form of the associated matrices. The related computer program proved to be extremely fast and economical in comparison to other existing methods of such analysis.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 695 source statements
PRICE: Program \$430.00 Documentation \$2.50
PROGRAM NUMBER: NPO-13244

STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue studies for structures and components; stress (including thermal) calculation and analysis of structures; analysis of vibration and damping in structures; analysis of shell structures including stresses, loads, buckling and vibration.

MASFLAY - Finite Element Mesh Generation Program

This program was written to perform finite element data preparation, It is to be used as an auxiliary program for finite element analysis and it prepares the input data on cards for programs which utilize the generated and controlled mesh. The mesh is generated for plane figures (two-dimensional or axisymmetric bodies) which are to be subdivided into quadrilateral and triangular elements for finite element analyses (structural, heat transfer, etc). The program has four steps of operation: (1) Missing data generation—(a) Generation of nodal point numbers, coordinates, and temperatures, and (b) Generation of element numbers, connectivities and material numbers. (2) Input data control-The program controls both the nodal point and the element numbers sequence. Calculation of the maximum difference in nodal point numbers belonging to an element is performed and printed. This information is often required to limit the stiffness matrix bandwidth in finite element analyses. (3) Control plot of mesh-The plots are provided using the line printer. (a) The nodal number is printed in correspondence of nodal coordinates in selectable scales, and (b) The element number at the element centroid is printed out in a plot with the same scales as that used in the node position plot. (4) Data cards are punched—Data cards are punched according to FORMATS chosen by the user if the option for punched data cards is chosen.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 360 source statements
PRICE: Program \$260.00

PROGRAM NUMBER: COS-02350

Isometric Piping System Drawing and Material Takeoff Program

The Isometric Piping Drawing System was designed to allow the engineer to have a fully dimensional isometric drawing produced for him. The system is comprised of five main parts. (1) Isometric Piping

Drawing-This produces an isometric drawing of the piping system viewed from any positive Y quadrant. It also produces a printed report describing all input data to the drawing system. (2) Isometric Symbol Drawing-This inserts pipe fitting symbols onto the pipin, drawing. (3) Material Report-Produces a plotted report listing index, description, length and stockcode number for each item in the system. (4) Instrument Point Report-Produces a plotted report which lists index, instrument number, description, stockcode number, and angular location pressure instrument branch connections, sample connections and temperature instrument thermowells, in the system. (5) Drawing Dimensions-Dimensions the piping system with extension line to It takes into account the problems of readability and dimension placement optimization. There are several favorable input features incorporated in this system. Each line of piping may be comprised of a number of elementary sections of pipe, which may either he straight lines or circular arcs, pipe fitting symbols may be inserted between any two consecutive points in the system. Instrument points may be inserted at any point in the system, and the physical properties of the piping material may change at any input data point in the system. The input for the computer program are data points necessary to define the piping system. The necessary inputs are: (1) Beginning points for a pipe line or segment, (2) Terminal points for a pipe line or segment, (3) Points of intersection of the tangents of the end of each circular bend in the pipe line, (4) Points at which the line changes direction without a circular bend, (5) Points at which a piping symbol is located, (6) Points at which pipe supports are located, (7) Points at which instrument point information is required. When a drawing run is completed, information consisting of input data, calculated values, and error messages are printed. The drawing is produced on a magnetic tape to be plotted by a Calcomp plotter.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: Univac 1108
PROGRAM SIZE: Approximately 8,230 source statements
PRICE: Program \$970.00 Documentation \$32.00
PROGRAM NUMBER: COS-02410

BANDIT - Structural Matrix Bandwidth Reduction Computer Program

BANDIT is a data preprocessor for use with the NASTRAN structural analysis computer program which automatically resequences the grid point numbers associated with structural matrices in order to reduce the band width of these matrices, i.e., produce a clustering about the main diagonal of the non-zero elements in the matrices with a resultant improvement in computational efficiency for NASTRAN. Although the structural matrices assembled by NASTRAN as a finite element based system are typically sparse and while many of the routines used by NASTRAN for the solution of linear equations and extraction of eigenvalues are designed to operate most efficiently when the bandwidths of the structural matrices are minimum; NASTRAN currently places the burden on the user to number the structure so as to provide such a bandwidth. The inherent difficulties in sequencing nodal labels manually can make this a burdensome task for the analyst. The current public release of BANDIT, Version 5.2., automatically resequences grid points using two different enumerative strategies, the Cuthill and McKee (CM) method and the Gibbs, Poole, and Stockmeyer (GPS) method. By default both strategies are invoked with the resequencing method selected being that which produces the minimal bandwidth. Alternatively, the user may specify that only one resequencing strategy to be used. Instead of bandwidth, the user may optionally select to reduce matrix profile, matrix wavefront, or row wavefront variance. BANDIT Version 5.2 is compatible with NASTRAN release levels 15.9 and below and recognizes the finite elements available in NASA NASTRAN Level 15.9, MSC NASTRAN and NAVY NASTRAN.

LANGUAGE: FORTRAN (5% ASSEMBLER CDC Version) MACHINE REQUIREMENTS: CDC 6000 Series, IBM 360 370 Series, UNIVAC 1100 Series, Honeywell 6000 Series

1- DGRAM SIZE: Approximately 3,899 source statements

PRICE: Program \$460.00 Documentation \$7.09
PROGRAM NUMBER: DOD-00033 (CDC), DOD-00034
(IBM), DOD-00035 (UNIVAC), DOD-00054 (Honeywell)

MEC21 - Pipe Flexibility Analysis Program

This is a pregram using tensor analysis methods to analyze the flexibility of multiple branch and closed-loop piping systems subject to thermal, uniform, and concentrated loadings, and is also applicable on cryogenic piping systems. All computations are performed in accordance with the requirements of ASA B31. 1-1955 American Standard Code for Pressure Piping. As an incidental feature, the program is also able to solve certain structural problems. The maximum problem size is 99 branches, 99 branch-intersection-points, and or 999 data points. Each data point may describe one to three elements. Machine time varies between 0.02 and 0.05 minute per element, depending on the complexity of the system.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series, UNIVAC
1100 Series

PROGRAM SIZE: Approximately 5,220 source stalements
PRICE: Program \$630.00 Documentation \$25.50
PROGRAM NUMBER: DOD-00024 (IBM Vers.), DOD-00025 (UNIVAC Vers.), DOD-00026 (CDC Vers.)

MEL40 - Piping Flexibility Analysis Program

MEL-40 is a computer program using tensor analysis methods to analyze the flexibility of multiple branch and closed-loop piping systems subject to pressure variations, temperature variations, anchor movements, weight, and or other prescribed loading conditions. All computations may be performed in accordance with the requirements of USA Standard Code for Pressure Piping. As an incidental feature, the program is also able to solve certain structural problems.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360-370 Series
PROGRAM SIZE: Approximately 5,273 source statements
PRICE: Program \$340,00 Documentation \$26,50
PROGRAM NUMBER: DOD-00027

SHCP - Ship Hull Characteristics Program

These are a series of programs that calculate ship areas, volumes, and centers. They operate on a data base which is applicable to almost any ship hull form. The programs have been sufficiently checked and tested to give reasonable assurance of valid answers, SHCP is composed of modular routines, each operating at one of three basic levels. Level 1-A miniscule executive (or monitor) routine which reads an identification card and a list of the work to be done, then supervises the performance of this work. Level 2--Output programs which read their own sets of data, perform their distinct types of calculations with the aid of Level 3 routines, print out their answers and return control to the executive. The first of these reads various combinations of design parameters, calculates the missing parameters, performs initializations and prints out design information. The remainder of the Level 2 programs are those which perform basic naval architectural calculations. They are: (1) Hydrostatics, (2) Trim Lines, (3) Longitudinal Strength, (4) Floodable Length, (5) Limiting Drafts, (6) Intact Stability, (7) Damaged Stability. These programs have stand alone capability; none need be aware of the existence of any of the others. Level 3-Working level, or calculation routines which perform all integrations, interpolations, and iterations,

LANGUAGE: LOW-LEVEL FORTRAN IV
MACHINE REQUIREMENTS: Any system with FORTRAN IV compiler. Examples: IBM-1130, IBM-360, IBM7090-7094, RCA Spectra 70, Burroughs B5500, UNIVAC1108, CDC-3000 and 6000 Series
PROGRAM SIZE: Approximately 5,365 source statements
PRICE: Program \$970.00 Documentation \$16.50
PROGRAM NUMBER: DDD-60030

1.

しろうかいないろこ

TOWER12 - Guyed Tower Analysis Computer Program

The program is based on a method of analysis which includes such secondary effects as external moments produced by the guys at each level and those produced by beam-column action. Effects of ice loads and insulators on the guys are also included. Within the limitations described below, the program will determine deflections, reactions, moments, and vertical loads for towers subject to loads which cause it to bend in one or in two directions. In addition, for triangular towers, stresses in all members can be determined for the following wind directions: (1) Wind directly into a face; Wind A, (2) Wind directly into an apex; Wind B, and (3) Wind parallel to a face; Wind C. If the guys at all levels are symmetric with the wind direction and there are no external loads in a direction other than the wind, Winds A and B load the tower symmetrically and the tower will deflect in the wind direction only. Wind C will cause the tower to bend in two directions because of dissymmetry. If the tower bends in one direction only, machine run time can be reduced by inserting the proper value for KS on the pertinent data card as described hereafter. Pull-off loading is assumed to be at the top of the cantilevered span. If there is no cantilevered span, the pull-off loading is assumed to be at the top guy level. This loading consists of a horizontal load, a vertical load, and a moment produced by the vertical load acting at some distance from the center of gravity of the tower. If there are no pull-off loads, the fields for such data are left blank.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 1,800 source statements
PRICE: Program \$530.00 Documentation \$8.00
PROGRAM NUMBER: DDD-20036

Midship Section Design for Naval Ships

This computer program will design the longitudinal scantlings of a midship section, Any practical combinations of decks, platforms, and longitudinal bulkheads for the midship section configuration may be used. Options to include an inner bottom structure and to perform a nuclear air blast analysis of shell and upper strength deck structure are provided. The program contains the decisions necessary to determine an initial set of minimum weight scantlings for the shell, deck bulkhead, and inner bottom segments, test them to determine compliance with the design criteria as defined by the Naval Ship Engineering Center, and then increase the scantlings if the criteria are not satisfied. Modification of scantlings continues until the scantlings developed do not change the primary stress assignment. If the midship section has a primary stress deficiency at the deck and or keel tibers, the program will automatically adjust the material at these fibers and iterate the design process until scantlings are found that are of minimum weight and structurally adequate. This program requires approximately 220K of memory in order to execute.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM CIZE: Approximately 10,000 source statements
PRICE: Program \$500.00 Documentation \$27.00
PROGRAM NUMBER: DDD-60041

GRID2D - IGFES: Two Dimensional Grid Generator and Terminal Control System

This software package represents a structural design program which generates two dimensional finite element grids. The package contains the GRID2D program, which is one of the programs comprising the Interactive Graphics Finite Element Systems; and also contains the Terminal Control System (TCS), which is a package of computer graphics routines designed to free applications programmers from graphics device dependent considerations. 135 interfaces GRID2D to graphic devices. The GRID2D program allows the user to define and display two dimensional structure, and supports the NASTRAN program. The grid generation process runs under control of a monitor. The user informs the monitor which phase of generation is to be performed. The phases are boundary definition, region definition, and monitor manipulation. By making multiple passes through each of these phases the user has the capability of regenerating regions many times using different nodal densities and element types. The restriction that opposite sides of the region must have an equal number of neces is basic to the generation process. Internally each god region is represented as a matrix. Thirteen NASTRAN elements are supported by GRID2D including the Twist element and the Axisymmetric trapezoidal ring element. The program operates in batch and interactive mode; currently runs in 80K bytes on an IBM 360 44 running OS MFT and 24K word PDP 11 40 under DOS BATCH; and uses the Calcomp plotter.

LANGUAGE: FORTRAN (95%); ASSEMBLER (5%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,078 source statements
PRICE: Program \$480.00 Documentation \$15.50
PROGRAM NUMBER: DDD-00050

Automated Input Data Preparation for NASTRAN

This program package consists of five computer programs which are available to aid the structural engineer in preparing input data for the NASTRAN structural analysis program. The first three programs -AXIS, SHELBY, and COONS—are coded in FORTRAN IV for operation on the IBM-7094 or the IBM-350 ccmputer; while the last two programs-BANDAID and MOVE-are coded in PL-1 for operation on the IBM-360 computer. Each program may be briefly described as follows: AXIS generates data for shells described by the rotation of a plane curve about an axis. SHELBY generates data for shells described by the translation of a plane curve along an arbitrary axis in space. The scale factor may vary along the length of the axis. COONS generates data for free-form shell structures based on the description of four bounding curves. BANDAID automatically resequences the grid points of a structural problem to achieve a reduced bandwidth in the stiffness matrix, given the NASTRAN data deck for the problem. MOVE generates data for structures having a number of identical segments, given the NASTRAN bulk data for one of the segments.

LANGUAGE: FORTRAN IV (59.6%); PL-1 (40.4%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,078 source statements
PRICE: Program \$490.00
PROGRAM L'UMBER: GSC-11033

Advanced Structure Geometry Studies

This report explains one method of subdividing a polyhedron into triangular facets and "exploding" it onto the surface of a sphere. A structure is thereby given which may be used in spherical form. The tetrahedron, octahedron or icosahedron are the fundamental geometrical configurations of the structure. A further subdivision of the configuration chosen is accomplished by subdividing each principle side of each principal polyhedral triangle into any number of segments. The order of subdivision is determined by subdividing the triangle and the origin (or center) of the polyhedron into equal angle segments, using the origin as the vertice for subdivision. The points of intersection of the equal angle segments with the principle side determines the subdivision along the principle side of the principle polyhedral triangle. The points of subdivision on each side of the Principle polyhedral triangle are connected with line segments which are parallel to the two remaining sides of the principle polyhedral triangle under consideration. They intersect at a number of points which define a triangutar grid of subdivision. Due to the method of subdivision, small triangular "windows" occur in the grid. The centers of these windows are found by one of two methods and are used as the vertices of a triangular grid of subdivision of the principle polyhedral face and are then transformed to the surface of the sphere which circumscribes the polyhedron. The cords that connect these transformed vertices thus define the structural grid that comprise the structural configuration desired. A mathematical mode! has been determined which explains the geometry used in subdividing and transforming the polyhedron into the structural configuration desired. From this model a computer program has been written which gives the necessary information needed for construction and analysis of the structure. As a further aid in investigation of the various forms, a plot routine was developed to give a graphical output of each of the structural forms.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-7094, Calcomp Plotter Model 740 PROGRAM SIZE: Not Applicable

PRICE: \$70.00 NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: HQN-10677

Structural Synthesis of a Stiffened Cylinder

This program designs minimum weight ring and stringer-stiffened cylinders which are subject to axial

and lateral pressure loadings. The basic approach is to regard weight as a merit function in the design variable space and then to determine the minimum weight by mathematical programming techniques. The program adjusts seven design variables; the thickness of the skin, and the thickness, depth, and spacing of solid, rectangular, integral rings and stringers; adjustments continue until the design of minimum weight is obtained. Cylinders are designed to prevent general and local buckling, and to prevent the skin and stiffener from yielding under prescribed loading conditions. The linear membrane prebuckling state is the stress state examined for buckling and yielding. The program considers stiffener eccentricity, provides for minimum gage limitations, and designs for multiple load conditions. The buckling and yielding failure conditions constitute constraints in the design variable space for the optimization problem. A penalty function method is used to convert the constrained problems which are solved by a gradient method.

LANGUAGE: CDC FORTRAN
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 1,700 source statements
PRICE: Program \$460.00 Documentation \$16.50
PROGRAM NUMBER: LAR-10473

Geometrically Nonlinear Analysis of Arbitrarily Loaded Shells of Revolution

A digital computer program for the geometrically nonlinear analysis of thin elastic shells of revolution subjected to arbitrary load and temperature distributions has been developed to predict snap buckling of shelf structures due to asymmetric loads. The analysis is based on Sander's nonlinear shell theory for the condition of small strains and moderately small rotations. During execution, the program solves a set of nondimensional linearized equ. is for each Fourier coefficient of the actual load, plus an estimated pseudo load from the nonlinear terms, using a finite difference formulation with a Gaussian elimination. The operational parameters of the program and the boundary conditions are read in on cards, but the geometry of the shell, the inplane and bending stiffness, and the pressure and thermal loads are introduced through user-prepared subroutines. The input and output data may be in either dimensional form or non-dimensional form. The program can be compiled in any order, and no special tapes, discs, or routines are required.

: ANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: CDC 6000 Series PROGRAM SIZE: Approximately 2,111 source statements PRICE: Program \$480.00 Documentation \$16.00 PROGRAM NUMBER: LAR-10736

Geometrically Nonlinear Static and Dynamic Analysis of Arbitrarily Loaded Shells of Revolution

The design of many shell structures is influenced by the geometrically nonlinear response of the shell when subjected to static and or dynamic loads. As a consequence, a number of investigations have been devoted to the study of the buckling phenomenon exhibited by shells. Most early works examine the behavior of the shallow spherical cap, the truncated cone, and the cylinder under axisymmetric loads. Due to the lack of information on the axisymmetric response of shells with other meridional geometries and on the response of shells subjected to asymmetric loads, a computer program for the geometrically nonlinear static and dynamic response of arbitrarily loaded shells of revolution has been developed. The program can be used to analyze any shell of revolution for which the following conditions hold: (1) The geometric and material properties of the shell are axisymmetric, but may vary along the shell meridian. (2) The applied pressure and temperature distributions and initial conditions are symmetric about a datum meridional plane. (3) The shell material is isotropic, but the modulus of elasticity may vary through the thickness. Poisson's ratio is constant. (4) The boundaries of the shell may be closed, free, fixed, or elastically restrained. The governing partial differential equations are based upon Sanders' nonlinear thin shell theory for the condition of small strains and moderately small rotations. At each load or time step, an estimate of the solution is obtained by extrapolation from the solutions at the previous load or time steps. The sets of algebraic equations are repeatedly solved using Potter's form of Gaussian elimination, and the pseudo loads are recomputed, until the solution converges. An automatic variable load incrementing routine is included in the program for the static analysis. Post-buckling behavior cannot be determined in the static analysis because of the method of solution employed. The documentation contains a description of the theory, the method of solution, instructions for preparing the input data, and two sample problems to illustrate the data preparation and output format.

LANGU'AGE: FORTRAN IV. Level H
MACHINE REQUIREMENTS: IBM 360-370
PROGRAM SIZE: Approximately 2,337 source statements
PRICE: Program \$720.00 Documentation \$11.50
PROGRAM NUMBER: LAR-11109

Computer Program for Stress, Vibration, and Buckling Characteristics of General Shalls of Revolution

The SRA system of programs is composed of six compatible computer programs for structural analysis of axisymmetric shell structures. The theory and method upon which these programs are based are presented in the documentation. They apply to a common structural model, but analyze different modes of structural response. They may be classified according to their function into three groups, designated here as the 100, 200, and 300-series. In particular, they are: SRA 100-Linear static response under asymmetric loads, SRA 101-Buckling of linear states under asymmetric loads, SRA 200-Nonlinear static responses under axisymmetric loads, SRA 201-Buckling of nonlinear states under axisymmetric loads, SRA 202-Imperfection sensitivity of buckling modes under axisymmetric loads, and SRA 300-Vibrations about

nonlinear states under axisymmetric loads. These programs treat branched shells of revolution with an arbitrary arrangement of a large number of open branches, but with at most one closed branch. Current dimensioning allows for seven branch points, each of which may have as many as five branches emanating from it. Branches which close at the axis of revolution; i.e., dome closures, are not considered to be closed branches. A maximum of 23 dome closures or other shell edges is allowed. At each meridional station, the shell wall may consist of as many as five orthotropic layers, in each of which elastic properties may vary only in the meridional direction. At each material point, the shell is assumed to possess orthotropic principal axes in meridional and circumferential directions. All geometric and mechanical properties of the structure are assumed to be axisymmetric, but may have arbitrary meridional variation. A continuous reference surface, arbitrarily located within or near the shell wall is treated. The shell may be stiffened by: (1) up to 34 discrete isotropic rings, (2) stringers, whose stiffness is circumferentially distributed, and (3) an elastic foundation attached to the shell wall. The effect of thermal loads and live pressure fields are included.

LANGUAGE: FORTRAN IV (99%); COMPASS (1%)
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 18,109 source statements
PRICE: Program \$650.00 Documentation \$34.00
PROGRAM NUMBER: LAR-11339

SNAP - Dynamic Structural Network Analysis Program, CDC 6000 Series Version

SNAP Dynamics is applicable to the same class of large linear finite element networks as the basic static analysis version of SNAP (LAR-11330). Undamped vibrational modes and frequencies of free or constrained systems are computed using an iterative procedure analogous to the stodola method of beam analysis. SNAP Dynamics executes a Rayleigh-Ritz analysis to obtain initial approximations of the first N modes and frequencies of the system (N is specified by the user). Generalized functions used in the Rayleigh-Ritz analysis are whole-structure static displacement functions computed by the program, based on a sequence of static loadings defined by the user. To assure that good approximations of the first N modes are obtained, 2N to 3N generalized functions are normally used. After the initial approximations of the modes have been computed, the program executes an iterative procedure to compute inivally the first (lowest frequency) mode, then the second mode, and so forth. Beginning with the initial approximation of a mode, an 'equivalent inertia loading' acting on the structure is evaluated. The static deformation corresponding to the inertia loading is computed, providing an improved approximation of the mode. This procedure is executed repeatedly until convergence is obtained. In computing higher modes, a process based on orthogonality relations is used to 'sweep out' lowfrequency components of each modal approximation. Routines from the basic static analysis version of SNAP are used to compute the successions of modal approximations. These routines take full advantage of system stiffness matrix sparsity to reduce computer costs to a virtual minimum. Advantage is also taken of system mass matrix sparsity in computing kinetic energy terms, equivalent inertia loadings, etc. Three optional methods of representing inertia effects are provided: (1) A diagonal system mass matrix may be used. In this case, the program automatically performs the necessary 'lumping' of distributed structural and non-structural mass. This method results in minimum computer costs and should be used if the finite element model reasonably supports a lumped mass approach. (2) Consistent mass matrice may be used for beams and certain membrane elements, (3) A 'Pseudo-Consistent Mass Matrix' method may be used. This method in effect assumes linear displacements for all elements, for purposes of kinetic energy and inertia force calculations. Input data includes: (A) A definition of the geometrical and physical properties of the structure (eg position coordinates of the structural 'Joints' at which the elements are interconnected, material constants, element section properties, etc.). (B) Constraint conditions. (C) Definitions of the static loadings from which displacement functions are computed for use in the initial Rayleigh-Ritz analysis. (D) Control parameters enabling the analyst to exercise an array of options governing modes of operation, output content, etc. Output data includes the following: (A) Frequencies and mode shapes. (B) Detailed comprehensive checks of numerical accuracy. (C) SC-4020 plots of both undeformed and deformed structure, generated by a very general system of automatic plotting routines. (D) 'Restart' tapes enabling problem solutions to be resumed, as required, without repeating preliminary steps such as formation and reduction of the system stiffness matrix, (E) Solution data output tapes for use in other programs. These tapes contain the system mass matrix, modes, and frequencies.

LANGUAGE: FORTRAN IV (98%): COMPASS (20%)
MACHINE REQUIREMENTS: CDC 6000 Series, SC
4020 Plotter
PROGRAM SIZE: Approximately, 17,000 source, state

PROGRAM SIZE: Approximately 17,000 source statements

DISTRIBUTION MEDIA: 7-Track SCOPE Formatted Magnetic Tape

PRICE: Program \$650.00 Documentation \$16.00 PROGRAM NUMBE.4: LAR-11529

SNAP-Static Structural Network Analysis Program. CDC 6000 Series Version

SNAP V70J is a finite element structural analysis system for executing linear analyses of large statically loaded networks of beam and shell elements. A companion program, SNAP Dynamics (LAR-11529) may be used for dynamic analysis of structures. The system consists of a main computational program called SNAP which executes basic solutions and an array of associated analytical and graphics display processor programs. Allowed loadings include point forces and moments at joints, non-zero specified joint motions (in oblique directions, if required), and thermal loadings. Output solution data includes joint motions (displacement and rotation components), element

stresses and or stress resultants, element nodal forces and strain energies, reactions, and automatic plotting of both undeformed and deformed structures. sparse matrix solution procedure is used in SNAP Statics which in many targe-scale practical applications affords very substantial savings in computer execution cost and data storage requirements, compared with band matrix, 'active column' or partitioning methods. The basic solution routines-'decomposition' of the stiffness matrix and forward backward solution for joint motions can approach the minimum computer costs theoretically obtainable using direct solution procedures (symmetric Gaussian elimination, Cholesky, etc.) Multi-dimensional 'network generators' of input data for element definitions, position coordinates, constraint, etc., are provided. The data input routines also make extensive use of 'libraries' of beam and shell section properties, material constants, etc., in generating problem definitions. This method can reduce the amount of manual effort (and probability of error) in preparing data decks for large structures. For example, the section properties of a beam are 'defined' by referring to the applicable set of data in one of the libraries. Accordingly, the detailed definition of each unique section appears in the input data only once, regardless of how many elements have that particular section. The force-deformation relations of individual elements are represented within the program by 'intrinsic stiffness matrices' expressing forcedeflection characteristics relative to intrinsic (moving) reference frames imbedded in the elements. A general set or routines evaluate element dimensions. orientation, etc., and compute contributions to individual elements to the complete system stiffness matrix. After system joint motions have been evaluated, other general routines (i.e. routines independent of the sources of the intrinsic stiffness matrices) compute element deformations relative to their embedded intrinsic frames, stresses, etc. This apparatus allows for the addition of new element formulations to the program, since it is accessary only to construct subroutines for computing the corresponding intrinsic stiffness and stress matrices, with element dimensions and section properties supplied through the calling sequence from the general routines. Plate shell membrane and bending element formulations based on 'hybrid' variational methods are included, providing substantial improvements in the accuracy of displacements and stresses. Options are retained for using other well-known element formulations for comparison. Beam elements include effects of shear center centroid offsets, transverse shear deflection, and nonuniform torsion. Section properties (moments of inertia, area, shear deflection constants, torsion constants, principal axis orientation, shear center location, etc.) may be input directly or the program will compute them for many types of sections (wideflanges, boxes, tube, angles, zees, channels, tees), given only the section dimensions as input. Detailed checks of numerical accuracy are automatically executed. In performing these checks the program returns to the basic problem definition; that is, the checks reflect not only the error accumulated in the 'factoring' and displacement evaluation procedures, but also the effects of round-off in assembling the system stiffness matrix (which, in most applications, is the primary

source of error). There are three checks, (1) a strain energy external work comparison, (2) a total applied force reaction comparison, and (3) an equilibrium check at all joints. An option is included for automatically executing an iterative accuracy improve-ment procedure. If, in its accuracy checks, the program detects numerical error in excess of a given tolerance (input by the user), this procedure is implemented which can result in 'salvaging' solutions that would otherwise be unacceptably inaccurate. The program is also structured for easy conversion to double-precision arithmetic as an alternative method of overcoming accuracy problems. Other user options available with SNAP Statics include: (a) Provision for temporary internal re-sequencing of joint numbers, to allow maximum ad-antage to be taken on SNAP's sparse matrix solution procedure. (b) Generation of 'restart tapes' enabling problem solutions to be resumed, as required, without repeating preliminary steps such as formation and reduction of the system stiffness matrix. (c) Partial executions principally for use in initial data debugging. (d) Reduction of the system stiffness matrix in double precision. (e) Automation of symmetry anti-symmetry constraint specifications. (f) Provision for rigid links offsetting beam element end points from the joints to which they are connected. (g) Reading of input data in 'block' formats for element definitions, joint position coordinates, and beam and shell section properties allowing local reference frames and local joint numbering arrangements to be used in various parts of the structure. This procedure allows data decks generated for individual parts of the structure to be merged with minimum effort to form a deck defining the complete structure.

LANGUAGE: FORTRAN IV (97%): COMPASS (3%)
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 20,000 source statements

DISTRIBUTION MEDIA: 7-Track CDC SCOPE Formatted Magnetic Tape
PRICE: Program \$550.00 Documentation \$21.00

PROGRAM NUMBER: LAR-11530

SALORS-Structural Analysis of Layered Orthotropic Ring Stiffened Shells of Revolution, Linear Stress Analysis Option

A computer program is presented for the linear static analysis of asymmetrically loaded, thin, elastic shells of revolution. The program is equipped to handle segmented, laminar, orthotropic shells with discrete rings. Provisions are made for handling meridional variations in material properties, temperatures, and wall thickness. The program also allows linear variations of temperature through each layer of the shell wall. Meridional discontinuities in geometry, temperature, and material properties and the actual load path through the joint at a discontinuity are accounted for. The effects of longitudinal stiffening (stringers) are automatically distributed circumferentially. Circumferential variations of loads and temperatures are handled by Fourier series expansion.

LANGUAGE: FORTRAN IV

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: CDC 6000 Series

PROGRAM SIZE: Approximately 3,000 source statements
PRICE: Program \$200.00 Documentation \$15.50
PROGRAM HUMBER: LAR-11553

BUCLAP2—A Computer Program for Instability Analysis of Laminated Long Plates Subjected to Combined Inplane Loads

This is a structurel analysis package containing approximately eight programs and thirty-one subroutines to predict theoretical buckling loads of long, rectangular flat and curved laminated plates with arbitrary orientation of orthotropic axes in each lamina. Few results are available in the literature for laminated curved plates. Thus, BUCLAP2 is expected to aid in achieving a better understanding of the buckling behavior of these curved plates, in addition to supplementing the available results for laminated flat plates. A structure and its displacement is represented by polar coordinates and strains are represented using the Kirchoff-Love hypothesis so that stress-strain equations for a lamina are in matrix form. The stability equations for laminated curved plates subjected to combined inplane normal and shear loads are derived by variational methods. Linear theory is used in buckling analysis. The solution is applicable to (1) finite length plates, when the plate is specially orthotropic and the combined inplane external loads do not include shear. and (2) infinitely long plates for all other cases. The buckling analysis considers rectangular flat or curved general laminates subjected to combined inplane normal and shear loads. Analysis oriented restrictions are as follows: (1) Linear thin shell buckling theory is used; (2) Prebuckling deformations are ignored; (3) Only inplane applied loads are considered; (4) The included angle of the curved plate is limited to 180°. The program operates in batch mode and presently runs under SCOPE 3.1 of KRONOS 2.0. All system subroutines used are standard CDC release. With the exception of three special purpose subroutines (PAC, UNPACK, and VIPDR in COMPASS) all source routines are coded in CDC FORTRAN IV. The overlay loading feature is used.

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 7,400 source statements
PRICE: Program \$760.000 Documentation \$25.50
PROGRAM NUMBER: LAR-11686

Torsional Vibration Natural Frequencies Program

This program computes the torsional vibration natural frequencies and corresponding mode shapes of a physical system under free vibration, that can be idealized to N lumped mass polar moments of inertia, cornected by weightless shafts possessing torsional stiffness. Both free-free and free-fixed and fixities can be accommodated. The method combines the best features of two techniques: the Holzer method and the Stodola method. The latter method obtains the highest frequency which is used for convergence of the Holzer iteration in a reasonable amount of time.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM-7094

PROGRAM SIZE: Approximately 474 source statements PRICE: Program \$230.00 Documentation \$3.50

PROGRAM NUMBER: MFS-01488

Column Analysis Complex

This is a FORTRAN IV digital computer program to evaluate the stability analysis of complex columns in the field of structures. Lateral deflection, internal moments, magnitude, position of the maximum ANC-5 interaction value, and the minimum margin of safety on each side of a pin-ended column are determined by this program. The effects of secondary bending assume external end moments cause bending in only one plane and that the axial loads act parallel to a straight line between the ends of the column. The centroidal axis is assumed straight before loading, but it may have a small parabolic warp which must lie in the plane of bending. The three general types of problems which can be analyzed by this program are: (a) To determine the stresses, deflections, interactions, etc. for a specific column due to a single loading condition; (b) To determine the stresses, deflections, interactions, etc. for a specific column due to a constant end moment and an axial load which increases to the critical value of load or stress; and (c) To determine the stresses, deflections, interactions, etc. for a column of varying length with a constant end moment and a varying axial load.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 213 source statements

PRICE: \$105.00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MFS-02227

Kellogg Piping Analysis Program, IBM-360 Version

This program uses the Kellogg General Analytical Method to facilitate the flexibility analysis of rocket engine propellant lines. A stiffness matrix approach is used since it lends itself naturally to complex configurations in three dimensions. The program accomodates up to 50 curved members and/or straight segments of single runs of piping. Flexibility and stiffness coefficients relating loads and deflections at the free-end are determined, Internal and free-end reactions due to specific free-end deflections can be found, as can internal reactions and free-end deflections due to specific free-end loads.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 850 source statements PRICE: Program \$350.00 Documentation \$2.50

PROGRAM NUMBER: MFS-12622

Stress Analysis of Belleville Springs Program

This program computes deflections, membrane forces, bending moments, stress, and the load-deflection history for conical shells (Belleville Springs) of uniform thickness. The program uses a large deflection theory, and is not restricted to the range in which deflection is proportional to the load. Program limitations are: (1) the shell must be thin and shallow, (2) symmetric sixal loads must be applied and reacted at the edges of the shell, and (3) no axial, radial, or rotational constraints can the enforced at either boundary. Significant errors were found in the results of computation using prior methods. These errors have been overcome by this program.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-7094

PROGRAM SIZE: Approximately 376 source statements PRICE: Program \$50.00 Documentation \$2.50 PROGRAM NUMBER: MFS-13217

SAMECS——Structural Analysis Method for Evaluating Complex Structures

The purpose of this program is to analyze large complex structures under various types of loading. The structure is described in rectangular coordinates by a set of control points (nodes) connected by plates and beams. Each node is assigned six degrees of freedom; rotations about each of the coordinate axes as well as displacements in the directions of the coordinate axes. Plates may be either triangular or quadrilateral, and beams may be either straight or curved and may have uniform or non-uniform section properties. Loads may be described as nodal or element loads. The assumptions normally made in structural analysis are assumed, i.e.: (1) The material is perfectly elastic; (2) The deflections are sufficiently small compared to the size of the structure that secondary deflections caused by interaction between the applied forces and primary deflections are negligible. Further it is assumed the structure can be adequately described as plates and beams. This program is limited to the evaluation of structures which can be adequately described by no more than 2,000 nodes. The total number of plates and/or beams is limited only by this restriction. Further, the nodes are grouped into partitions, and the maximum number of rows of partitions is 200, with a maximum of ten nodes per partition. The total number of partitions in the stiffness matrix is limited to 800.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108 EXEC VIII
PROGRAM SIZE. Approximately 6,397 source statements
PRICE: Program \$420 00 Documentation \$11.50
PROGRAM NUMBER: MFS-15302

Torsion Analysis of Open Sections

An open section is a section in which the centerline of the wall does not form a closed curve. Channels, angles, Ibeams, and wide-flange sections are among many common structural shapes characterized by combinations of thin-walled rectangular elements; a variety of thinwalled curved sections is used in aircraft and missile structures. The basic characteristic of these sections is that the thickness of the component element is small in comparison with other dimensions. This program performs the torsional analysis of thin walled open sections for both unrestrained and restrained torsion sections. Torsional shear stress, angle of twist, and warping deformations are determined for unrestrained torsion. Torsional shear stress, warping shear stress, warping normal stress, angle of twist, and the first, second, and third derivatives of angle of twist are determined for restrained torsion

LANGUAGF: FORTRAN IV
MACHINE REQUIREMENTS: IBM-7094
PROGRAM SIZE Approximately 836 source statements
PRICE: Program \$140.00 Documentation \$10.50
PROGRAM NUMBER: MFS-20648

Vibrational Transfer Functions for Base Excited Systems

A general computer program, GD203, has been developed for computing vibrational transfer functions for complex structures excited by a base motion. In the design of complex structures the governing vibrational environ-

ment is generally specified in terms of either a sinusoidal or random base environment. In either case the response of the subject structure can be evaluated through the use of vibrational transfer functions. The primary input to the program are modal properties of the system. The program is capable of handling modal properties developed through modal coupling techniques with a maximum of 162 degrees of freedom per structure and up to 150 substructures. The program capability includes plotting of the computer transfer functions. The program could be utilized by the aircraft industry where induced vibration environments and structural response to these environments are used in the design of critical structure. Further application could include the automotive industry in computing response of vehicles to specified road environments.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 771 source statements
PRICE: Program \$350.00 Documentation \$6.50
PROGRAM NUMBER: MFS-21432

FORMA——Synthesis Of Dynamic Systems Using FORTRAN Matrix Analysis

A library of computer programs called FORTRAN Matrix Analysis (FORMA) has been developed in order to find efficient solutions of small and medium size structural dynamics problems of up to 150 degrees of freedom. The library consists of 86 subroutines that may be combined in the form of "building blocks" that may be used to solve a large variety of structural dynamic problems. The obvious advantage of the "building block" approach is that the only programming and checkout time required is putting the necessary blocks together in the proper order. The FORMA library includes routines for beam mass matrix calculations, beam stiffness matrix calculations, eigenvaluevector solutions, time response solutions as well as the basic matrix algebra subroutines. The FORMA method has advantageous features such as: (1) Method will work on any computer with a FORTRAN IV compiler. With minor modifications it has been used on the IBM-7044/7094/360. GE 625/635, CDC 6400/6500. and UNIVAC 1108; (2) Computer times are reasonable: (3) Incorporation of new subroutines is no problem; (4) Basic FORTRAN statements may be used to give extreme flexibility in writing a program. (5): An analyst can program relatively complex problems with very little programming experience; (6) The method of programming is closely related to the manner of the mathematical formulation of the physical problem; and (7) Subroutines in the library have been used extensively for many years and as a result are well checked out and debugged. The documentation for FORMA consists of four volumes: Methodology: Programming Manual; Subroutine Explanation; and Subroutine Listings

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: Any computer with FORTRAN
IV Compiler (present version, UNIVAC-1108)
PROGRAM SIZE: Approximately 15,000 source statements
PRICE: Program \$1,500.00 Documentation \$32.50 (volumes 1, 2, 3 only)
PROGRAM NUMBER: MF5-21490

SNAP——Dynamic Structural Network Analysis Program, UNIVAC 1108 Version

SNAP, Dynamics is a computer program written to calculate the normal modes of an arbitrary structure from

a finite element mathematical model. The strong feature of the finite element technique is its suitability for accurately characterizing extremely complicated structures for which determination of exact analytical solutions are impossible. The basic version of SNAP is an extremely general program for linear analysis of statically-loaded linear finite element networks. The computer execution costs achieved by the basic static solution routines are very close to the minimum that can possibly be attained using direct solution procedures, generally affording substantial savings when compared with the costs associated with constant or variable-width band matrix, active column, or partitioning solution methods used in other programs. This can be extremely important in analyzing large complicated structures. SNAP's allowable number of degrees of freedom is extremely large. Structures having over 15,000 elements and 12,000 degrees of freedom have been solved, and much larger problems can easily be handled. The sparse matrix solution technique entirely eliminates stiffness matrix band width restrictions. Very efficient use is made of both core and secondary data storage resources. Dynamic allocation of core storage is automatically implemented by the program to optimize size capacity and execution efficiency for each individual analysis. An option is included for automatically executing an iterative accuracy improvement procedure. If, in its accuracy checks, the program detects numerical error in excess of a given tolerance, this procedure is implemented. The computer execution cost is very small, and often results in salvaging solutions that would otherwise be unacceptably inaccurate. Optionally, double precision arithmetic may be used as an additional means of overcoming accuracy problems.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108, SC-4020 Plotter
PROGRAM SIZE: Approximately 17,000 source statements
PRICE: Program \$1,750.00 Documentation \$33.50
PROGRAM NUMBER: MFS-21531

ASTROS——Automated Shell Theory for Rotating Structures

The ASTROS computer program can be used to analyze any disk or shell of revolution of arbitrary cross section under mertial loads caused by rotation about the shell axis and various static loads, including thermal gradients. The geometric shapes incorporated in the program are ellipsoidal, spherical, ogival, toroidal, conical, circular plate, cylindrical, and parabolic. The program was developed because of a need for an easy-to-use and accurate computer program that is oriented directly toward solving for the stresses and deformations in rotating disks and shells of revolution such as those encountered in rocket engine turbomachinery. This program has advantages over other similar programs in that it uses larger segments of the structure than when the tinite difference method is used. Therefore, the input to the program is minimized resulting in a larger program capability and more accurate results. Four classifications of information are used as program input: (1) Geometry Data - the geometric description of each segment of the disk or shell or revolution. (2) Material Data - thickness and material properties of the segment. (3) Topology Data the manner in which all the segments are interconnected to form a structure. (4) Load Data - temperature and loading data, both concentrated and distributed, and angular velocity. Many features of this program such as treatment of the branched shells, stiffened wall construc-

٤,

tion, and thermal gradients are retained from a computer program named STARS II (Shell Theory Automated for Rotational Structures II) which was developed by the Grumman Aircraft Engineering Corporation.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 5,000 including 3,000
data cards
PRICE: Program \$750.00 Documentation \$27.00

PROGRAM NUMBER: MFS-21970

STARS2S - Shell Theory Automated for Rotational Structures (Statics)

These programs use the Love-Reissner first order shell theory method to assist in the numerical analysis of the shells of revolution and can analyze orthotropic thin shells of revolution subjected to unsymmetric distributed loading or concentrated line loads and thermal strains, or they can perform stability or vibration analysis of thin shells of revolution subjected to axisymmetric distributed loading or concentrated line loads and thermal strains. The shell wall cross section used can be a sheet, sandwich, reinforced sheet or reinforced sandwich. The reinforce ment can consist of rings and/or stringers, a waffle construction rotated at any angle to the principle coordinates, or an isogrid construction. The reinforcement material properties can differ from those of the main shell, and a temperature variation can cause different properties in the two face sheets of the sandwich shell. The basic approach to the problem is to cut the structure into several shell segments, each being free to have its own geometric shape, provided the shape falls into one of the categories mentioned below. Stiffness matrices obtained for each segment are coupled by standard matrix methods to obtain region stiffness, which, after being reduced in size, are in turn ccupled to form the total shell structure under analysis. The shells that can be analyzed with these programs can consist of any combination of the following geometric shapes: (1) Ellipsoidal - spherical. (2) Ogival toroidal, (3) Modified ellipse shape, (4) Conical - circular plate, (5) Cylindrical, (6) General point input geometry, (7) Dummy geometry slot to be filled by the user, (8) Discrete ring, and (9) Elastic support.

LANGUAGE: FORTRAN V

MACHINE REQUIREMENTS: UNIVAC 1100 Series. Exec 8 PROGRAM SIZE: Approximately 25,000 source statements DISTRIBUTION MEDIA: 7 track UNIVAC FURPUR Formatted Tape

PRICE: Program \$2,410.00 Documentation \$131.50 PROGRAM NUMBER: MFS-23027

PANES - Program for Analysis of Nonlinear Equilibrium and Stability

This program was developed to utilize improved techniques for analysis of structures with material and geometric nonlinearities, including the limit point and bifurcation behavior which occurs in buckling and collapse problems. The methods used in this program are "incremental loading." Newton Raphson iteration and its modifications, involving periodic updating of the Jacobian matrix and higher order methods including various orders of predictor and corrector algorithms. In order to make current methods applicable to cases of large strain and arbitrary nonlinear materials, the equation generation process is accomplished in the present work by a finite difference expansion procedure. It is found that generation of the nonlinear equations by this means within a

perturbation context provides a unifying basis for definition of the nonlinear solution terms, including as special cases the first-order Newton Raphson and incremental loading methods, as well as almost an unlimited variety of higher-order solution techniques. The perturbation procedures have the advantage of a sound theoretical basis in classical developments, and lend themselves readily to both limit point and postbuckling problems as well as to simple nonlinear behavior without critical points.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM 360/370

PROGRAM SIZE: Approximately 2,554 source statements
PRICE: Program \$200.00 Documentation \$14.00
PROGRAM NUMBER: MFS-23172

Remote Access Terminal Circular Frame Computer Program

This program calculates the internal moment axial, and shear loads on a rigid 'circular' frame, inner and outer cap stresses are also included in the output. The program uses a minimum energy solution. The applied loads are first balanced, yielding the balanced static loads. The balanced static loads and the redundant loads are then related, using energy equations to determine the final internal loads. The program's main application is for preliminary analysis of circular frames for rocket vehicle and aircraft structures, although it is also applicable to other industries using circular frames. The program's main advantage is that it eliminates the time delay and cost of running a large production program for frames with less than forty section cuts.

LANGUAGE FORTRAN IV. IBM Assembler MACHINE REQUIREMENTS IBM 360 RAX Terms. at System

PROGRAM SIZE: Approximately 793 source statements
PRICE: Program \$50 00 Documentation \$3 50
PROGRAM NUMBER: MFS-24042

FRAP - Pressurized Structure Optimization

This program was developed to optimize the weight of orthotropic cylinders with stiffeners and rings subjected to axial compression. The program computes (a) skin panel buckling stresses and load levels; (b) compression and associated stress levels of pressurized and non-pressurized structures (short column effects are included); (c) gross and effective section properties of the cylinder wall, (d) optimum ring frame geometry, and (e) equivalent thicknesses of the cylinders under consideration.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360 RAX System PROGRAM SIZE: Approximately 260 source statements

PRICE: \$25 00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: MFS-24043

CAPR - Compression Allowable Plotting Routine

This program is written for plotting design stress strain, effective modules (Et and Es), compression buckling (Fcr), and compression crippling (Fcc) curves for new materials or materials for which these curves are not available. The input of the program requires the three Ramberg Osgood

parameters (n, E, and F0.7) which mathematically describe the material stress-strain curve, the design yield strength (Fcy), and Poisson's ratio (u).

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 1130

PROGRAM SIZE: Approximately 550 source statements

PRICE: \$45 00

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MSC-12705

Fracture Mechanics of Apollo Spacecraft Pressure Vessels

This computer program performs a fracture mechanics evaluation of Tr 6Al-4V pressure vessel cyclic pressure histories using techniques that conform to NASA specifications. Evaluation results for each pressure vessel are defined in terms of maximum potential flaw depth based on its cyclic pressure history. This flaw depth is then interpreted as remaining allowable pressure cycles to a selected evaluation pressure and also interpreted where applicable as maximum allowable temperature when pre: surized to the selected evaluation pressure. The input to the program consists of tank parameter data, tables used for interpolation of certain variables, and pressure cycle data. The output consists of desired tank condition parameters such as temperature, maximum expected flaw size and number of pressure cycles that can safely be applied to the tank. The present program is limited to cylindrical or spherical Tr-6Al-4V pressure vessels. The program could be generaled to allow an assessment of pressure vessels of any type of material. The constants input for any particular material would have to be determined from experimental data on that material.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 292 source statements
PRICE: Program \$160.00 Documentation \$5.50
PROGRAM NUMBER: MSC-13995

SOR-Shells of Revolution

Stiffness and Mass Matrices (SAMMSOR) - Stiffness and Mass Matrices for Shells of Revolution are generated utilizing this program. This program accepts a description of the structure in terms of the coordinates and slopes of the nodes and the properties of the elements joining the nodes. For shells with simple geometries (such as cylinders, shallow caps, hemispheres, etc.) the shell geometry can be internally generated. Utilizing the element properties, the structural stiffness and mass matrices are generated for as many as twenty harmonics and stored in magnetic tape. This program generates the input data to be used by other stiffness of revolution programs. Our advantage of creating the stiffness and mass matrices in a separate program is that a variety of analyses can be performed on the same shell configuration without having to create the matrices more than once.

Dynamic Nonlinear Analysis (DYNASOR) - The equations of motion of the shell are solved using Houbolt's numerical procedure with the nonlinear terms being moved to the right-hand side of the equilibrium equations and again treated as generalized loads. The displacements and stress resultants can be determined for both symmetrical and asymmetrical loading conditions. Asymmetrical dynamic buckling can be investigated using this program. Solutions can be obtained for highly nonlinear problems in

reasonable periods of time on the computer utilizing as many as five of the harmonics generated in SAMMSOR. A restart capability is incorporated in this code which allows the user to restart the program at a specified time without having to expend the computer time necessary to generate the prior response.

Frequencies and Modes (FAMSOR) - Using the stiffness matrix generated by SAMMSOR and a lumped mass representative developed from the consistent mass matrix generated by SAMMSOR, a specified number of natural frequencies (beginning with the lowest or fundamental frequency) are obtained using the inverse iteration method. The mode shapes for each of the frequencies are also obtained. The natural frequencies and mode shapes can be found in reasonable periods of computer time utilizing this code.

Static Nonlinear Analysis (SNASOR) - The Static Nonlinear Analysis of Shells of Revolution (SNASOR II) subjected to arbitrary mechanical and thermal loading is performed using this computer program. Utilizing the stiffness matrices generated by SAMMSOR and the loading conditions and boundary conditions input to SNASOR II. the equilibrium equations for the structure are generated. The nonlinear strain energy terms result in pseudo generalized forces (as functions of the displacements) which are combined with the applied generalized forces. The resulting set of nonlinear algebraic equilibrium equations is solved by one of several methods. Newton-Raphson type iteration, incremental stiffness method, and modified incremental stiffness method. In general, the Newton Raphson procedure is the best and yields accurate results for highly nonlinear problems in a reasonable computer time. Symmetrical and asymmetrical large deflection problems have been solved using this code Buckling loads for symmetrically and asymmetrically loaded shells (with moderately large prebuckling deflection) have been obtained and checked with other solu-

LANGUAGE: FORTRAN IV PROGRAM SIZE: Approximately 7,000 source statements PRICE: Program \$840.00 Documentation \$53.50 PROGRAM NUMBER: MSC-14748 (CDC 6000 Version). MSC-14749 (IBM 360 Version)

Geometry Processor, Mesh Topology and Nodal Point Generator

In order to create the mesh topology and nodal point coordinates for a finite element stiffness method model for a large structure, large amounts of data must be generated. Generating this data requires large manpower expenditures; input errors are numerous and expensive to debug. In order to minimize these problems, the Geometry Processor computer program calculates cartesian coordinates and defines structural elements from such basic values as radius and angles for cylindrical or cone type structures. The coordinates and elements are graphically displayed by CRT plots and punched in BCD format. The program also contains a "Table of Equivalent" which relabels the coordinates or elements identification.

LANGUAGE FORTRAN IV (65.2); ASSEMBLER (35%) MACHINE REQUIREMENTS: IBM 360, SC 4020 plotter PROGRAM SIZE: Approximately 2,573 source statements PRICE; Program \$420.00 Documentation \$13.00 PROGRAM NUMBER: MSC-17031

FMA - Frame Modal Analysis

FMA is a computer program that was initially developed for the dynamic analysis of the S-11 program but has since been modified and capabilities added in order to make vibration analyses of many structures, primarily during preliminary design. The primary purpose of the program is to calculate the natural frequencies and modal displacements of three-dimensional frame structures. In addition, the program may be used to generate the stiffness and mass matrices of frame structures for use in subsequent analyses. A general beam element and consistent mass matrices are employed in the idealization. If required by problem size, the structure may be divided into several structures or sections prior to calculation of modal characteristics. Considerable flexibility in the arrangement of structural degrees of freedom is provided to the user. Input data includes member sectional properties and weights plus coordinates of the node points at which the members join. Stiffness matrices for each beam member are generated and combined to form the structure stiffness matrix using the direct stiffness method. A consistent mass matrix is formed using the stiffness information and the weight input data. Node shapes and frequencies are then calculated by the Jacobi method using the mass matrix and stiffness matrix. The stiffness matrix, and/or nodes may be saved on magnetic tape for future use.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 852 source statements
PRICE: Program \$160.00 Documentation \$12.50
PROGRAM NUMBER: MSC-17562

Program to Reduce the Size of Structural Matrices

There are programs available to reduce the size of stiffness matrices, but none to reduce both stiffness and mass matrices. This program was developed to reduce both the mass and stiffness matrices to a size that will enable the modal program to calculate mode shapes and frequencies. The reduction is accomplished by eliminating degrees of freedom using the Cholesky decomposition. The program performs a Guyan (consistent mass) reduction on any structural mass and stiffness matrices. This reduction allows calculation of Eigenvalues of a smaller matrix than would otherwise be required. Assuming sufficient auxiliary storage (on tape, disk, or similar device), the matrix sizes that may be reduced are essentially limited only by the cost. Three double precision arrays and two integer arrays (each of the length of one row of the matrix) are required to be in core at any one time. Efficiency is greatly improved, however, if more core is provided since the program automatically utilizes all available core. Accuracy is dependent upon the conditioning of the input matrices and the accuracy with which the input matrices were formulated.

LANGUAGE: FORTRAN G and H
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 704 source statements
PRICE: Program \$140.00 Documentation \$5.50
PROGRAM NUMBER: MSC-17619

STRESS - Structural Thermal Rapid E. aluation - Stresses and Strains

A computer program was written to determine the internal stresses and strains resulting from thermal

gradients. In prior analyses either the problem was solved longhand which was very time consuming, or a general purpose finite element program was used with a large amount of input data which was also time consuming. The STRESS program has simple input data and provides rapid turnaround whice I leads to parametric studies and "quicklook" evaluations. This program has been used to evaluate the thermal protective systems on the space shuttle by the North American Rockwell, Space Division.

LANGUAGE: FORTRAN G
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 132 source statements
PRICE: \$75.00
NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.
PROGRAM NUMBER: MSC-17931

SAMIS - Structural Analysis and Matrix Interpretive System

SAMIS is designed to solve problems involving matrix arithmetic, with particular emphasis on structural applications. The program can execute, either exclusively or. sequentially, two basic operations. From input data that define an idealization of a structure, the generation phase of the program generates structural matrices for any type of element available in the program element library. This phase is based upon the structural concepts of the finite element method, in particular, the stiffness or displacement method. To enable the program to analyze a range of structural types (truss, plate, shell, composite shell beam, etc.), several elements are programmed and cataloged in the program element library. Contained in the library are the general line element suitable for representing axial, bending, and torsion deformations, and the triangular plate element which models membrane and bending deformations. The second basic operation is termed the manipulative phase, in which either generated or input matrices are manipulated according to the rules of linear algebra. In structural problems, the matrix manipulations may be sequenced to compute displacements, stresses. reaction faces, or mode shapes and frequencies. The ability to compute these quantities for structural systems which are described by a large number of simultaneous e nuations requires greater than in-core data access and storage capacity. Because of this requirement, the program was developed as a chain system. Based mainly upon the constraint of computer running time, the SAMIS program operates efficiently with matrices ranging from the 100th to 2500th order.

LANGUAGE: FORTRAN (2% Assembler UNIVAC Version) MACHINE REQUIREMENTS: CDC-6000 Series, UNIVAC 1100 Series PROGRAM SIZE: Approximately 19,000 source statements (CDC Version), Approximately 18,000 source statements (UNIVAC Version) PRICE: CDC Version - Program \$2,060.00 Documentation \$51.00 UNIVAC Version - Program \$1,590.00 Documentation \$48.50 PROGRAM NUMBER: CDC Version - LAR-10050 UNIVAC Version - NPO-11319

ELAS8—A General Purpose Digital Computer Program for the Equilibrium Problems of Linear Structures

ELASS is a general purpose digital computer program that can handle the equilibrium problems of linear structures of one-, two-, or three-dimensional continuum.

The program requires as input (1) the coordinates, in an over-all coordinate system, of the mesh points of a random one, two, or three-dimensional mesh established in the material volume of the structure of one, two, or three dimensional continuum, respectively; (2) the geometrical, topological, material, and loading characteristics of the mesh elements; (3) the list of prescribed deflections and forces at the mesh points; and (4) a few program control parameters. As output they provide (1) the deflections at the mesh points, (2) the stresses at the mesh points, and (3) the listings of the input data. The solution is obtained by means of the displacement method and the finite element technique. Almost any geometry and structure may be handled because of the availability of linear, triangular and quadrilateral, tetrahedral, hexahedral, conical, and triangular and quadrilateral torus elements The piecewise linear deflection distribution assumption. which is used, insures monotonic convergence of the deflections from the stiffer side with decreasing mesh size The stresses are provided by the best-fit strain tensors in the least-squares sense at the mesh points where the deflections are given. The selection of local coordinate systems whenever necessary is automatic. The core memory is efficiently used by means of dynamic memory allocation, an optional mesh point relabelling scheme. imposition of the boundary conditions during the assembly time, and the straight line storage of the rows of the stiffness matrix within variable bandwidth and the main diagonal. The number of unsuppressed degrees of freedom that can be handled in a given problem is 500 to 600 for a typical structure, but might far exceed these average values for special types of problems. Options available to users include: (1) The ability to change the size of the labeled COMMON to fit the problem being solved without recompilation. (2) Production of a tape file containing all the output, which may be processed at a later time by means of the ELAS. PLOT program to obtain mesh, curve or contour plots of various quantities.

(3) Minimum Output (INP=0) line size of either 72 or 120 characters

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE: Approximately 6.955 source statements
PRICE, Program \$680.00 Documentation \$32.50
PROGRAM NUMBER: NPO-11555

COMTANK - Structural Design and Stross Analysis Program for Advanced Composite Filament-Yound Axisymmetric Pressure Vessels

A computer program, COMTANK, has been developed to design and analyze advanced composite filament-wound axisymmetric pressure vessels. The purpose of the program is to enable the user to automatically develop a detailed vessel design and perform a complex stress analysis of the design in an efficient and cost-effective manner. The program has been specifically developed to handle planar-wound pressure vessels fabricated of either boron/epoxy or graphite/epoxy advanced composite material. The vessel may or may not contain a cylindrical midsection; i.e., the tank configuration may be that of a cylinder with dome closures or an oblate spheroid. In the former case, provision has been made to accept unequal boss openings in the forward and aft domes, In general, input to the program must be provided in three basic categories. (1) Tank description, consisting of geometry and material property data. (2) Design loading condition; and (3) Analysis loading conditions. The tank description consists of a definition of overail tank geometry and component geometry relating to the liner, bosses, and shirt attachments. The design loading condition consists of internal pressure only. The analysis loading conditions consist of internal pressure, boss line loadings, and temperature gradients through the tank wall. Items (2) and (3) above indicate that it is possible to analyze a pressure vessel design for loading conditions other than those for which it was designed. Given the proper input, COMTANK will perform computations to provide output that describes a detailed pressure vessel design and stress analysis. The vessel design consists of midsurface coordinates defining the entire tank and shirt support element geometry: element wall thicknesses throughout the structure, ply construction, enclosed volumes, weight breakdowns, and material property details relating to filament tape wrap angles of coefficients of thermal expansion. The stress analysis consists of the entire displacement field of the structure, element nodal forces, stress resultants and couples, and point stress analysis, giving a detailed breakdown of the longitudinal, transverse, and shear stress in each layer of the composite of the point of consideration. The program makes a call for subroutine TICK which calculates the CPU time of a particular run The user will have to supply his own TICK subroutine or remove the small amount of logic that utilizes the CPU

LANGUAGE, FORTRAN V
MACHINE REQUIREMENTS: UNIVAC 1100 Series
PROGRAM SIZE Approximately 7,079 source statements
PRICE: Program \$610 00 Documentation \$7 00
PROGRAM NUMBER: NPO-11943

WAVEFRONT - Structural Stiffness Matrix WaveFront Resequencing Program

WAVEFRONT is a preprocessor computer program that resequences the nodes of the structural stiffness matrix by means of a wavefront reduction algorithm prior to entering a standard structural analysis computer program. The input and output are oriented to produce computational advantages and core-storage reductions particularly within the NASTRAN structural analysis program. The submitted version of WAVEFRONT will resequence a structure consisting of up to 600 nodes and 1,800 connection edges, using 36,000 words of core storage. The foregoing size definitions can be readily changed by updating one procedure element and recompiling (with no changes to the source elements) portions of the remaining program elements.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
program size; approximately 599 source statements
PRICE: Program \$350 00 Documentation \$5 00
PROGRAM NUMBER: NPO-13322

Finite Element Analysis of Compressible Solids With Nonlinear Material Properties

The program is designed to determine displacements and stresses within plane or axisymmetric solids with linear or nonlinear properties, using the finite element method. In the finite element approximation of solids, the continuous body is replaced by a finite number of discrete triangular or quadrilateral element inconnected at joints or nodal points. Approximation are developed relative to the behavior of any one element and applied to the solution of the continuous structure. Equilibition

equations, in terms of unknown nodal point displacements, are developed at each nodal point and the solution of this set of equations constitutes a solution to the system. The stress in the solid is found from the displacements at the nodes. The options in the program include axisymmetric solids analysis, plane stress analysis, nonlinear (plastic) analysis, and equivalent stress and strain (according to the Von Mises yield condition). Advantages of the finite element method compare: Nother numerical approaches are numerous: (1). The method is completely general with respect to geometry and material properties (2). Complex bodies composed of many different materials are easily represented. (3). Since anisotropic materials are automatically included in the formulation, tilament

structures are readily handled. (4) Displacement or stress boundary conditions may be specified at any nodal point within the finite-element system. (5) Arbitrary thermal, mechanical, and accelerational loads are possible. (6) In addition, the finite element approach provides equilibrium equations which produce a symmetric, positive definite matrix which may be placed in a band form and solved with a minimum of computer storage and time.

LANGUAGE: FORTRAN H
MACHINE REQUIREMENTS: IBM 360/370
PROGRAM SIZE: Approximately 1.477 source statements
PRICE: Program \$340.00 Documentation \$11.00
PROGRAM NUMBER: NUC-10342

THERMODYNAMICS AND : COMBUSTION

Includes thermodynamic and transport properties; combustion processes and analysis; thermal protection systems; heat transfer; and heat exchangers.

Subroutine for the Thermodynamic Properties of Steam and Water

SMTAB was developed to determine the thermodynamic properties of steam and water. The properties as determined by this program agree closely with the properties abulated in the Keenan and Keyes tables. Table look-up was not used because of inefficiency and large amounts of core storage required. Instead, SMTAB makes use of Keenan and Keyes' equations, as well as curve-fitting and surface-fitting techniques, to determine the required properties.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7090
PROGRAM SIZE: Approximately 327 source statements
PRICE: Program \$230.00
PROGRAM NUMBER: DOD-00007

Nodal Network Thermal Balance Program

This program is an update to an earlier thermal balance program that covered all stages of spacecraft life, from faunch to orbital dynamic steady state. Internal heat exchange by conduction and radiation is determined, given the appropriate conductances, radiation view factors, and effective emittances. The program employs an implicit solution method, inverting the matrix of linearized data by the Gauss elimination method. Recent improvements and additions to the program include features which extend the basic thermal computations. Additional thermal computation options include a feature for maintaining at any desired constant temperature those nodes designated as "isothermal," an algorithm for estimating the power input (or output) required to maintain any given node at any desired temperature, a means of imparting a variable emittance to any node, a new transient mode associated with an exponentially expanding time period, and an option for going into steadystate node after the last transient period. The program generates an extensive table with a node-by-node energy balance for every node in the model, a table giving the node-by-node components of the heat leaks by key nodes. and a table summarizing nodal temperatures at successive time periods

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-360

PROGRAM SIZE: Approximately 1,679 source statements PRICE: Program \$440.00 Documentation \$7.00 PROGRAM NUMBER: GSC-11158

General Transient Heat Transfer Computer Program for Thermally Thick Walls

This is a general heat-transfer program which employs a finite-difference method for the solution of temperature histories of one-dimensional, two-dimensional or spherical systems. Options are available for heat input given in tabular form, computed from a trajectory, or computed from a temperature history given for a special location. The types of heat exchange are: (1) conduction; (2) convection with (a) given heat input, (b) heating due to skin friction with Van Driest equations. (c) stagnation heating with Sibulkin, Detra-Kemp-Riddell, and Cohen equations; (3) radiation-out; (4) air-conduction; and (5) joint conduction. The system configuration is specified by an arbitrary number of discrete elements and their interrelationships

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-6000 Series
PROGRAM SIZE: Approximately 2.795 source statements
PRICE: Program \$420.00 Documentation \$17.00
PROGRAM NUMBER: LAR-10794

Program for the Transient Reponse of Ablating Axisymmetric Bodies Including the Effect of Shape Change

A computer program has been developed to analyze the transient response of an ablating axisymmetric body including the effect of shape change. The governing differential equation, the boundary conditions for the analysis on which the computer program is based, and the method of solution of the resulting finite-difference equations are discussed in the documentation. Some of the features of the analysis and the associated program are (1) the ablation material is considered to be orthotropic with temperature-dependent thermal properties; (2) the thermal response of the entire body is considered simultaneously; (3) the heat transfer and pressure distribution over the body are adjusted to the new geometry as ablation occurs; (4) the governing equations and several boundary-condition options are formulated in terms of generalized orthogonal coordinates for fixed points in a moving coordinate system; (5) the finite-difference equa-

tions are solved implicitly; and (6) other instantaneous body shapes can be displayed with a user supplied plotting routine. The physical problem to be modeled with the analysis is described by FORTRAN input variables. For example, the external body geometry is described in the W. Z coordinates; material density is given; and the stagnation cold-wall heating rate is given in a timedependent array. Other input variables are required which control the solution, specify boundary conditions, and determine output from the program. The equations have been programmed so that either the International System of Units or the U.S. Customary Units may be used. Calculations from this program may be saved for plotting purposes but the user will have to supply his own plotting routines.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: CDC-6000 Series

PROGRAM SIZE: Approximately 1.679 source statements PRICE: Program \$540.00 Documentation \$11.00 Documentation \$11.00

PROGRAM NUMBER: LAR-11049

FORTRAN IV Program for Calculation of Thermodynamic Data

This program calculates ideal gas thermodynamic properties for any species for which molecular constant data are available. These thermodynamic properties can be calculated in several ways. For monatomic gases, three methods are given which differ in the technique used for truncating the partition function. Unobserved but predicted electronic energy levels may be included. For diatomic and polyatomic molecules, five methods are given which differ in the corrections for nonrigid rotation, anharmonicity and vibration-rotation interactions. Excited electronic states may be included. The initial thermodynamic functions calculated by the program are heat capacity. enthalpy, entropy, and free energy. These functions are fit to empirical equations and, as a function of temperature. heats of formation and equilibrium constants are calculat ed from assigned reference elements and/or from these elements in their atomic gaseous state.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM 360

PROGRAM SIZE: Approximately 3,572 source statements PRICE: Program \$350.00 Documentation \$13.00

PROGRAM NUMBER: LEW-10254

Computer Program for Calculating the Thermodynamic and Transport Properties for Eight Fluids - Helium. Methane, Neon, Nitrogen, Carbon Monoxide, Oxygen, Argon, Carbon Dioxide

A computer code, GASP, has been developed to provide thermodynamic and transport properties of the following fluids: argon, carl on dioxide, carbon monoxide, fluorine, helium, methane, neon, nitrogen, oxygen, and para hydrogen. The equation of state and transport coefficients are updated and other fluids added as new material becomes available. GASP accepts any two of pressure, temperature or density as input condition. In addition, pressure and either entropy or enthalpy are also allowable input variables. The properties available in any combination as output include temperature, density, pressure. entropy, enthalpy, specific heats, expansion coefficient. sonic velocity, viscosity, thermal conductivity and surface tension. A special technique is provided to estimate the thermal conductivity near the thermodynamic critical point. Properties are calculated at pressures from 0.1 to

200 atmospheres (to 100 atm. for helium) and at temperatures from near the triple point to 300 K for neon, to 500 K for argon, carbon dioxide, fluorine and para hydrogen, and from 5.2 to 500 K for helium (restricted use below 5.2 K). The GASP package was developed to be used with heat transfer and fluid flow calculations, and as such has broad application. It appears to be particularly useful in the many applications or pryogenic fluids. Some of the problems associated with liquification, storage and gassification of liquified natural gas and liquified petroleum gas can also be studied using GASP.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-7094/7044 DCS PROGRAM SIZE. Approximately 2,183 source statements PRICE: Program \$440.00 Documentation \$9.00 Documentation \$9.00 PROGRAM NUMBER: LEW-11629

ATMA - Aerotherm Charring Materials Ablation Computer Program

The Aerotherm Charring Materials Ablation (ACMA) program is an implicit, finite difference compulational procedure for computing the one-dimensional isotropic transient transport of thermal energy in a three dimensionall isotropic material which can ablate from a front surface and which can decompose in depth. The ablating surface boundary conditions involve considerations of surface thermochemistry. In principle, these surface thermo-chemical calculations could be performed within the ACMA program; however, it has proved more expedient to do these calculations in a separate program and use the tabulated results in the ACMA program. A number of programs may be used to provide the surface thermochemistry information. One program specifically intendes for this purpose and specifically designed to complement the ACMA program is the Aerotherm Chemica, Equilibrium Program (ACE) (Reference: LEW 11722). The output from ACE can be used directly as input to the ACMA program.

LANGUAGE: FORTRAN IV MACHINE REQUIREMENTS: IBM-7094 PROGRAM SIZE Approximately 1.935 source statements PRICE: Program \$260.00 Documentation \$14.00 Documentation \$14.00 PROGRAM NUMBER: LEW-11854

Regenerative Cooling Design and Analysis Computer

This computer program was written for the design and analysis of a regeneratively cooled rocket engine, however, the program may be used for any convectively heated and cooled device. The influences of heat transfer, stress and cycle life are evaluated. Coolant passages may be formed by tubes or channels with or without a gas slide wall coating. These passages may be designed based on a specified gasside wall temperature, coolant side wall temperature, cr coating temperature distribution. Also a design may be analyzed with a specified contant passage size distribution to determine the resulting wall temperatures and the coplant pressure drop. Options contained in the computer program include a two dimensional thermal analysis model of a tube or channel cross section which uses a relaxation technique with a variable number of nodes. Also a transierit them at solution is provided by a quasi two-dimensional thermal model for considering influences of engine start, shutdown or throtoing. Another option is the determination of structural safety factor and the cycle life of a design

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 6,429 source statements
PRICE: Program \$350.00 Documentation \$25.00
PROGRAM NUMBER: LEW-12110

Computer Program for Calculating Water and Steam Properties

A computer subprogram Water and Steam Properties (WASP) was developed to calculate the thermodynamic and transport properties of water and steam. The temperature range is from the triple point to 1750 K (2690°F), and the pressure range is from 0.1 to 100 MN/m2 (1 to 1000 bars) for the thermodynamic properties and to 50 MN/m2 (500 bars) for thermal conductivity and to 80 MN/m2 (800 bars) for viscosity. WASP accepts any two of pressure, temperature, and density as input conditions. In addition, pressure and either entropy or enthalpy are also allowable variables. This flexibility is especially useful in cycle analysis. The properties available in any combination as output include temperature, density, pressure, entropy, enthalpy, specific heats (Cp and Cv), sonic velocity, (OP/Op)t, (OP/OT)p, viscosity, thermal conductivity, surface tension, and the Laplace constant. The thermodynamic properties are based on calculations using the Helmholtz free-energy equation of Keyes, Keenan, Hill and Moore; the transport properties are calculated by using standard curve fits in regions where these equations exist and are interpolated elsewhere. Temperature and all the other properties can be obtained as a function of pressure and enthalpy (or pressure and entropy).

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 1,629 source statements
PRICE: Program \$610.00 Documentation \$12.50
PROGRAM NUMBER: LEW-12206

BETA II - Boeing Engineering Thermal Analyzer

BETA II uses numerical methods to provide accurate heat transfer solutions to a wide variety of heat flow problems. This new version of the original BETA increases its capabilities and broadens its options as well as making the program available to second generation computers such as the IBM System 360. The program will solve steady-state and transient problems in almost any situation that can be presented by a resistancecapacitance network. The continuous physical system in question is replaced by a "lumped" network system analogous to a resistance-capacitance network. Numerical equations that represent this network exactly are then solved. The solution is accomplished in a step-by-step or iterative fashion. Given a network of temperatures at each node, the computer makes a pass through the network using the numerical equations to predict the temperature at each node a short time later. This process of predicting the new temperature from the old is repeated for many iterations until the problem is solved.

LANGUAGE: FORTRAN H (98%) BAL (2%)
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 10.564 source statements
PRICE: Program \$1.000 00 Documentation \$48.50
PROGRAM NUMBER: MFS-15055

Thermal Analysis of Fluid Flow in a Pipe

Differential equations governing the thermal transient of fluid and wall temperatures for flow in an exposed constant

diameter pipe are developed. These equations are solved with an IBM-360/Model 67 computer to obtain fluid and wall temperatures for increments of pipe length at time increments during a thermal transient. The computer program, has the capability of solving heat transfer problems for fluid flow systems with a variable external thermal environment for the pipe and variable inlet fluid temperature and flow rate. This item may be used for the heat transfer analysis of fluid flow systems with a variable external thermal environment for the pipe and variable inlet fluid temperature and flow rate. Possible extensions include the analysis of vacuum jacketed and insulated piping systems. The techniques used could also be extended to include the thermal analysis of exposed cryogenic piping systems during cooldown and frost formation.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 300 source statements
PRICE: Program \$340.00 Documentation \$16.00
PROGRAM NUMBER: MFS-15148

RAVFAC - Radiation View Factor Program

This program represents a new technique for calculating diffuse radiation view factors, using contour integrals. The technique is combined with the finite difference (double summation) technique to compose this program package. Two techniques for calculating radiation view factors were included in this program because the contour integral offers greater accuracy and the finite difference offers faster run times. A combination of the two provides accurate results and keeps the run time within reason. A technique was also incorporated into the program to account for the effects of shading by other surfaces. There is a routine that reduces run time by eliminating surfaces that cannot cause shading on the areas for which the view factors are being calculated. The program provides the heat transfer engineer with a tool for rapid and accurate calculation of radiation view factors between systems of complex surfaces. These view factors are necessary for calculation of surface temperature distributions of vehicles exposed to heat sources.

LANGUAGE: FORTRAN V
MACHINE REQUIREMENTS: UNIVAC-1108
PROGRAM SIZE: Approximately 2,170 source statements
PRICE: Program \$260.00 Documentation \$18.00
PROGRAM NUMBER: MFS-21075

FNG - Fluid Network Genera or

This program uses the Fleid Network Generator to standardize and simplify anymonmental control system thermal modeling. The program reduces analyst time to set up a complex fluid system computer model from weeks to minutes and makes complex fluid system trade-off studies practical. The program automates the environmental control system modeling technique and is well suited for parametric studies, proposal efforts, preliminary design studies, and project thermal efforts.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC-600 Series
PROGRAM SIZE: Approximately 809 source statements
PRICE: Program \$160.00 Documentation \$10.50
PROGRAM NUMBER: MFS-21082

l-2

SINDA - Systems Improved Numerical Differencing Analyzer

This program is written to assist in the thermal analysis of spacecraft and other bodies. This is usually an empirical process that grows in complexity as the size of the body being analyzed gets larger. By combining the Kalman filter with an electrical network analogy, it becomes possible to describe the thermal distribution as the sum of conduction and tadration time functions. The parameters falling out of the analysis form the coefficients for conduction and radiation terms suitable for computerization. However, to obtain a true temperature profile of a body requires a large number of data points or nodes. It has been found that the upper brint for rapid computerization is 100 nodes, which would indicate the elimination of networks with, say, 1,500 nodes. An existing computer program called CINDA 3G (Reference MSC 11653) has provided the basis for developing the SINDA program that can handle both the analysis of a 100 nodal areas the body may have to be divided into in order to obtain the required temperature profile the new program is called SINDA Improved Numerical Differencing Analyzer. This fightly modified version of CINDA 3G contains numerous subron time additions. The major differences between SINDA and CINDA 3G are. (1) channation wherever possible of assembly language coding, (2) additional informatic options to aid the program user in data input. (3) inclusion of a second pseudo compute sequence for evaluation of nonlinear network elements, and (4) additional subrou tines such as STEP (sensitivity analysis) and KALORS KALER (Kalman filtering). The additional innomine options provide for a source data block, nodal capacitance as a composite, polynomial representation of temperature varying conductors, etc. Subroutines are used for thormal network correction. These subroutines use the Kalman filtering technique. SINDA program options offer the user a variety of methods for solution of thermal analog medes presented in a network format. The network represents a one to one, correspondence, to both the physical and mathematical models. SINDA contains numerous subrou tines for handling interrelated complex phenomena such as sublimation, diffuse radiation within an enclosure, simultaneous 1.D incompressible fluid flow including valving and transport delay effects, sensitivity analysts and thermal network corrections method

IANGUAGE FORTRAN V and STEUTH (UNIVAC 1108 Machine Language)
MACHINE REQUIREMENTS UNIVAC 1108, EXEC V111 system Six tape and or disc units required for operation PROGRAM SIZE Approximation 16,702 source statements PRICE Program \$2,410.00 Documentation \$42.50 PROGRAM NUMBER: MSC-13805

General Heat Transfer Program

A simple transient heat transfer program has been written for use on the IBM 360 RAX system. The program inclindes conduction, convection, and radiation interchange. The program is capable of handling radiation to space, applied heat thoses, and boundary temperatures. The heat thoses and boundary temperatures the heat thoses and boundary temperatures may be input as functions of time. Multi-damensional problems of up to 30 nodes may be considered.

LANGUAGE, FORTRAN IV MACHINE REQUIREMENTS, IRM 360 System PROGRAM SLT. Approximately 195 source statements PRICE \$50.00

NOTE. The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing. PROGRAM NUMBER: MSC-17026

Phase Change Subroutine for Use with Finite Differencing

Programs

Previously, phase changes which began or terminated during a time step of finite differencing programs resulted in heat balance errors. This subroutine eliminates errors due to finite time steps and greatly simplifies the inclusion of phase change type materials into thermal math models. The program employs interpolation methods which results in eliminating the accuracy dependency on time step durations. It allows any number of phase change nodes to be handled by one "dop in" subroutine. Any finite differencing technique that is used on systems employing phase change materials can use this subroutine.

LANGUAGE FORTRAN IV
MACHINE REQUIREMENTS IBM 360
PROGRAM SIZE Approximately 45 source statements
PRICE \$70.00
NOTE The pince includes the documentation and a
program listing only. The documentation is not sold
separately from the pengram listing.
FROGRAM NUMBER: MSC-19184

Determination of View Factors to Finite Surfaces Using the H.P. Desk Computer

This program will calculate view factors from points to any surface bounded by straight line segments. The procedure is based on a Stokes theorem transformation of the basic view factor area integral to an equivalent contour integral. For areas not bounded by straight line segments, a result can be obtained by approximating the area with straight line segments.

LANGUAGE Computations and data are entered at time of processing.

MACHINE REQUIREMENTS: HP 9820A.

PROGRAM SET: Not Applicable.

PRICE \$25.00.

NOTE: The price includes the documentation and a program listing only. The documentation is not sold separately from the program listing.

PROGRAM NUMBER: MSC-19500.

Computer Program for the Steady-State Temperature Analysis of Plane or Axisymmetric Bodies

This digital computer program using the finite element analysis technique has been developed to determine the steady state temperature distribution within plan or axisymmetric solids. The continuous body is replaced by a system of trangular or quadrilateral elements. Each element is numbered. Each nodal point of each element is identified by its Vand Y coordinate. Input into the program consists of nodal point identification, temperature or beat flow at boundary nodal points, material identification of each element, conductivity of each material, and convective heat transfer coefficient and temperature at each boundary usdal point. Each quadulateral element is divided into four triangular elements. The conductivity matrix for each triangle is formed and then combined to form a 5 x 5 conductive matrix with respect to the five points. The 5 x 5 matrix is then reduced to the 4 x 4 quadrilateral conductivity matrix by standard techniques. The quadrilateral conductivity matrix is then added to the conductivity matrix for the complete body. The nodal point temperatures are then found from the solution of the resulting matrix equations. Within the program this is accomplished by a large capacity matrix solver. All temperatures are then printed. A particular feature of this program is that it provides output which is compatible for input to available finite element stress analysis programs.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 7094
PROGRAM SIZE: Approximately 736 source statements
PRICE: Program \$280.00 Documentation \$6.00
PROGRAM NUMBER: NUC-10049

TRACK - Computer Program for Transient and Steady State Coupled Fluid Flow and Heat Conduction Analysis

This program is designed to compute detailed transient and/or steady state fluid conditions (flow, fluid temperature and pressure distributions) and spatial material temp erature distributions for reactor components and other types of heat exchange apparatus or components. The specified conditions are the geometric parameters of the flow system which consists of multiple, parallel fluid channels for cooling of the solid material, plena initial conditions, the solid body geometry which can be arbitrary in shape and internal nuclear heat generation rates of the solid materials, if any. The transient solution at the end of a time step is obtained by iterating the channel wall temperatures between the fluid flow and the heat conduction analysis. The procedure starts with a trial channel wall temperature distribution. The fluid flow calculation distributes the fluid between the various flow channels, calculates the convective heat transfer coefficients, the coolant temperature and pressure distributions along the channels. Either the total flow rate or the system overall pressure drop between inlet and outlet plenum may be specified. The coolant temperatures and the heat transfer coefficients thus obtained are applied as boundary conditions to the heat conduction computation. The resultant channel wall temperatures are compared to the trial channel wall temperatures used in the fluid flow calculation, iterations continue until the channel wall temperatures are within a specified tolerance at the end of the time step. Computation then proceeds to the next time step. Similar procedures are used for steady state determination. A transient problem can be started after a steady state solution is obtained. The program utilizes a finite difference solution to solve the governing transient fluid flow and heat conduction equations. It can handle up to 46 parallel flow channels with various single phase fluids. The heat conduction model may be two or three dimensional and consist of different solid materials with temperature dependent properties.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6000 Series
PROGRAM SIZE: Approximately 4,918 source statements
PRICE: Program \$680.00 Documentation \$11.50
PROGRAM NUMBER: NUC-10189

AUTOTEM - A Computer Program for Automated Geometry Meshing and Heat Conduction Calculation

In calculation of a temperature distribution for an arbitrary irregular body by a finite difference solution, the body must first be divided into a finite number of lumped masses or nodal points. AUTOTEM generates the majority of the input data required for the analysis (the description of the physical nodal system). The program generates this data automatically and calculates the temperature distribution for a two-dimensional plane section in (x, y) coordinates or axially symmetrical irregular body in (r, z) coordinates. There are four major sections: (1) meshing of the peripheral nodes, (2) generating of the regular interior nodes and input data required by the temperature calculation codes. (3) calculating of the temperature distribution, and (4) plotting of the general nodal network and isotherms. The data generated from one section are stored on tape and are punched out on cards. The execution of the problem can be stopped at the end of any one section for examination. The AUTOTEM code can handle any two dimensional (constant in the third dimension) or axial symmetrical hody consisting of a single material. Time dependent internal heat generation. temperature dependent material thermal properties and time dependent boundary conditions can be considered. This program is missing subroutines, TLFL and TIMEX, but these routines can be omitted without loss of executability

LANGUAGE: FORTRAN IV (98.6%): ASSEMBLY (1.4%)
MACHINE REQUIREMENTS: CDC 6600, SC 4020 plotter
PROGRAM SIZE: Approximately 10,719 source statements
PRICE: Program \$1.030.00 Documentation \$9.50
PROGRAM NUMBER: NUC-10241

TAPA - Program for Computing Transient or Steady-State Temperature Distributions

This program solves problems involving transient and steady state heat transfer in multidimensional systems having arbitrary geometric configurations, boundary conditions, initial conditions and physical properties. It is capable of considering different modes of heat transfer and boundary conditions such as internal conduction and radiation, free and forced convection, radiation at external surfaces, specified time dependent surface temperatures, and specified time dependent surface heat fluxes. The program will also handle space and time dependent thermal conductivity and heat capacity. In addition, the external boundary (environmental) temperatures may be functions of time. Either explicit or implicit mathematical methods may be used to solve the difference equations. The implicit method uses an overall heat balance on the body being investigated as well as the usual temperature convergence criteria. While stability and convergence of the solution are automatically provided by the program, the user has control over the accuracy of the solution and the amount of output data produced.

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: CDC 6600
PROGRAM SIZE. Approximately 1,775 source statements
PRICE Program \$490.00 Documentation \$16.00
PROGRAM NUMBER: NUC-10282

COSMIC INDEX TERM (KEYHOPG) INCEX

ABERRATION			
	OSRTI-OPTICAL SYSTEMS RAY TRACING	•	
ABLATION	OSTITUTE STATE AND INTERNO		55
LAR-11047	ENWHITES SEASON FOR THE SAME SAME SAME		
L 4R-11801	OF SHAPE CHAPCE	S INCLUDING THE EFFECTS	92
ABLATIVE MATE	ACMA-AFROTHERM CHARRING MATERIALS ABLATION COMPUTER PROGRAM.		72
ACE	CHEMICAL EQUILIBRIUM OF ABLATION MATERIALS INCLUDING CONDENSED SPECIES	•	17
	175-15001.70# 51.5000.		
ACRA	ACE-AEROTHERM CHEMICAL EQUILIBRIUM COMPUTER PROGRAM		10
	ACMA A COOKING A CANADA		
	ACMA-AERCTHERP CHARRING MATERIALS ABLATION COMPUTER PROGRAM		92
ACOUSTIC MEAS			
	ATRICRAFT NOTSE SOURCE AND CONTOUR ESTIMATION COMPUTER PROGRAM		. 7
ACOUSTICS			
LEV-12785	PESFARCH CENTER	S USED AT THE LEWIS	,
ADIABATIC FLO			
	DUCT-ADIABATIC CEMPRESSIBLE FLOW DUCT ANALYSIS PROGRAM		.50
ADRIS			
K\$C-10619	ADMIS-AUTOMATEC CATA PARAGEMENT INFERMATION SYSTEM		25
ADV ECT 10%			
UGA-02333	QUAL 1-SIMULATION OF WATER QUALITY IN STREAMS AND CANALS		53
AERIAL PHOTOG	RAPHY		
GSC-12079 MSC-14823	SMIPS-SMELL INTERACTIVE IMACE PROCESSING SYSTEM LARSYS III-ML1TI:PECTRAL DATA ANALYSIS		55
AERODYHANIC CI	MARACTERISTICS		٠.
LAR-11013 LAR-11047	A DESIGN SUMMAPY OF STALL CHARACTERISTICS OF STRAIGHT WING ALPORAFT VORTEX LATTICE FURTHAN PROCRAM FOR ESTIMATING SUBSONIC AFRODYNAMIC CHAPACTE	RISTICS OF COMPLEK	7
LAR-11250 LAR-11305	THERETICAL PREDICTION OF INTERFERENCE LOADING ON AIFCRAFT STORES-SUPERSONI AN IMPROVED FEHED FOR THE AFRODYNAMIC ANALYSIS OF WING-RODY-TAIL CONFIGURA		8
LAR-11573	MODIFIED MULTHOPP SUBSCRIC LIFTING SUPFACE METHOD OF AFRO CHAPACTERISTICS		2
AERODYNAHIC CO			
LAR-11197 LAR-11727	COMPUTER PROGRAM TO DETERMINE PRESSURF DISTRIBUTION AND FORCES ON BLUNT BOD SUBSCRIC ANNULAR WING THEORY WITH APPLICATION TO FLOW ABOUT NACELLES	TES OF REVOLUTION	l 2
AERODYNAMIC FO			
C4R-11249	THEORETICAL EFECTOTION OF INTERFERENCE LOADING ON AIRCRAFT STOTES-SUBSONIC	CASE .	7
AERODYNAMIC WE	AT TRANSFER		
MSC-19493	STARTCH NUMBER-SEPODYRAPIC HEATING		6
AERODYHAMIC HE	ATING		
£42-11044	CENERAL TRANSIENT HEAT TRANSFER COMPUTER PROGRAM FOR THERMALLY THICK MALLS COMPUTER PROGRAM FOR THE TRANSIENT RESPONSE OF ARLATING EXISTMMETRIC RODIES OF SHAPE CHANCE	THOLUDING THE EFFECTS	91 92
	STARTON RUMEER-SEROCYRAMIC PEATING		6
AERODYNAMIC LO			
	THEORETICAL EFFCICTION OF INTEFFFENCE LOADING ON AIPCPAFT STOPES-SUBSCRICE THEORETICAL PREDICTION OF INTEFFEDENCE LOADING ON AIFCPAFT STORES-SUPERSONIC MODIFIED MULTHOPF SUBSCRICE LIFTING SUPFACE METHOD OF AFRO CHARACTERISTICS	ASE CASE	7 6 2
AERODYNAMIC ST			٠
EAR-IIOI3	A CESSON SUPPARY OF STALL CHARACTERISTICS OF STRAIGHT WING AIRCPART	ORIGINAL PAGE IS OF POOR QUALITY	7

AE	RODYNAMIC S	STRUCTURFS			
	1 FW-11 10	FIRE L-ANALYSIS OF JEE ENGINE BURSE-BOTER CONTAINMENT DEVICES			. :
46	ROTHERMOCH				5
	LFW-11850	ACMS-RENCTHERP CHAPPENG PATERIALS APLATION COMPUTER PROGRAM			
4 F	ROTHERMON				12
	ME 5-210F)	STUPLIFIED FELTE SYSTEM THERMAL ANALYSIS			
AF	SDP				93
	. #45-10164	AFSOP-A GUICE TO THE PUTCHATED ENGINEERING AND SCIENTIFIC OPTIMIZATION PROGNAN			
AG	F FACTOR	THE STATE OF THE S		•	65
	MF 5-21071	RETARY-MISEC ESTEMATED RETEREMENT ANNULTY CALCULATION PROGRAM			
AT	-				43
	446-14443	SESOF PROGRAM FOR SOLAR ENERGY HEATING SYSTEMS ANALYSIS			
AI	COOLING	, and the state of			15
	#SC-14853	SESCR- HOGRAM FOR SCLAN FAFROY HEATING SYSTEMS ARALYSTS			
AT	POLLUTION	100 Martin 21215.2 www(4212			12
	MF 5-71114	HAN SOOK FOR ESTIMATING TODIC FUEL HAZARDS			
	NPO-1[847	AT MIL - WIND TRAJECTORY TRACING FOR ATR POLLUTION STUDIES			57
Ats	CRAFT DESI		200		٠.
	LAR-11011	A DESIGN SUMMARY OF STALL CHARACTERISTICS OF STRAIGHT WING ATREBAFT			7
AIR	CRAFT LAND	ING			·
	MFS-71871 MSC-17472	TAKEDEE AND LANDING PERFORMANIE LAGLOP-LANDING GEAR LEFES EROGRAM			42
ATE	CRAFT MOLIC				•
	44C-10880 144-11-44	STRUBBLE NOTES SCINCE AND CENTURE ESTIMATION COMPUTER PROGRAM AN INDRINARD METHOD FOR DESIGN OF EXPANSION CHAMBER MITERERS MITH APPLICATION TO AN OPE HELICULULA	FRECTTAFF		7 P
418	CRAFT PERFC	IRMANCE			
	wrs-21871	TAKEME AND LINDING PERFERMINGE			
ATR	CRAFT STRUC	No.			42
	MF 5-21432 MF 5-24042	VINEATIONAL TERNSFER FUNCTIONS FOR PASE EXCITED SYSTEMS. RAN-REMOTE ACCESS TERMINAL CIRCULAR FRANK COMPUTER PROCESS			
AIR					80
	NPO-11447	ATRPOL-WING TRAJECTORY TRACING FOR PER POLLUTEON STUDIES			
ALG	FBRA				43
	K3N-13734	AFLICTUMES LIBER ALGERPA LIRRARY	•		
	LFH-17417 LFH-10417 MF5-02486	FORTRAN TV PERGERM FOR SUMPRITE SOLUTION OF UP TO 20 SIMILITANEOUS EQUATIONS MATHER CONSISSATIONAL PROFESSOR TO MATERIX CALCINATIONS FOREST AND IMPLEMENTATION POINT TRANSFERMATION-CONFOCRAPHIC OF PROPERTY.			6.6
41 G d	ORETHUS	POINT TRANSFERMATION-COMPORABATION TO PROPOSITION FOR THE MENTATION USE			70
	148-11124	Utila transaction			
	MF 5-77497 MSC-14673 MPG-13344	ALTIMATIC COMPLIER SIMPPOGRAP SELECTICA FECH APPLICATION PROGRAM LIBRARIES A COMPUTERIZE' SCLUTTCH IF THE REPSERVENCE PETHOD ALGORITHM ASTEPHATORITHME SIMPLATICATEST AND EVALUATION PERCADA SPIN-FREE VI-RATION ANALYSIS OF SPINNING STRUCTURAL SYSTEMS			.6 63
4660	CATIONS	A TOTAL OF STREET STREET SANTENS			76
	K5C-13419 M65-18141	ENGISTICS HARTWARE AND SERVICES CONTROL SYSTEM LAME THE APPORTMENT AND CENTREL PROCRAM			10
	MNUMERIC CI				60
		CSS-CHARACTER STRING SCHANER			
	RNATIVES	The state of the s			23
		A COMPUTEREZEC SOLUTION OF THE REPNER-TREADE METHOD ALGORITHM			
LTE		THE STREET OF THE STREET, STRE			41

MF 5-00465	AMINT-ADAMS PILLTON INTERPATION SURPOUTINE	70
AMPLIFICATION		
MES-14044	MEN-CENTROL PRECESS PERSONNES MENIMEN PHASE FROM VARIANCE GAIN CHARACTERISTICS	. 34
ANALING STRULAT	(Ca)	
MFS-22672 NIC-10376	MARSYAS-MAPSHALL SYSTEM FOR AEROSPACE SIMILATECN COMMITTER PRICERM CALCLEATES PIPING-SYSTEM PAPAMETERS	43 50
ANALYTIC FUNCT	trus'	
445-13436	CONMIN-A FURTRAY PROCESH FOR CONSTRAINED FUNCTION MINIPILATION	
ANALYZERS		
144-11694	PROGRES FOR INTERFACING A HEMLETT-PACKARD MODEL 9830 CALCULATOR WITH A HEMLETT-PACKARD MODEL 5401 B.	27
ANGLE OF ATTAC		
1 67-11197	A DESIGN SUPPLY OF STALE CHARACTERISTICS OF STRAIGHT WING AIRCRAFT COMPUTER PROGRAM TO DETERMINE PRESSURE DISTRIBUTION AND POSCES ON NUMBER POORES OF REVOLUTION AN IMPROVED RETHICO FOR THE AERODYNAMIC ANALYSIS OF WING-ROOM-TAIL CONFIGURATIONS IN SURSIMIC AND SUPPRISONS FOR	; !
ANGLES EGENEET	RYI	
4F 5-024 PG	POINT TRANSFERRATION-CRAMMIC TO PERSPECTIVE, FORTEAN H VEHSLON FOR 360 SYSTEM USE	13
AMGULAR DISTRI	RUT TOM	
45[-14091	A PEGGRAP FOR CEPTUTING THE BRIGHTNESS TEMPERATURE OF A CLEAP ATMOSPHERE FROM BEDIOSONOF DATA	43
ANTIR AR FE DU		
144-11727	SUBSCULT ANNELSE BLAG THEORY WITH APPLICATION TO FLOW APOUT NACELLES	2
APPLICATIONS O	F MATHEMATICS	
485 - 10169 655 - 11499 154 - 12495	AFRON-A GUIDE TO THE AUTOMATED ENGINEERING AND SCIENTIFIC OPTIMIZATION PROGRAM SECREC-SECUTICANCE ARTTEMENTS EXPERIMENTAL PACKAGE OLIGITAL ERDONAM FOR SCILVING THE LIMEAR STOCHASTIC OPTIMAL CONTROL AND ESTIMATION PROBLEM FERM VERSIONS	66 37
APPLICATIONS P	PROGRAMS ECCHPLIERS)	
(48-11124	ALTELES-ALTOMATIC COMPLTER SURPRIGRAM SELECTION EROM EPPLICATION PERCHAMILIBRARIES	. 26
APPROXIMATION		•
MF 5-11127 MF 5-22136		70 71 72 74
APRICT		
455-24014	APRICT-APPIRATION MENTAPPECTEUN	62
ARCHETECTURE		
mp-02032	SHOP-SHIP HULL CHARGOTERISTICS PROGRAM	78
ARRAYS		
#F5-01178 #F5-15045	CODER-BLOCK COMMON NON-EXECUTABLE STATEMENT GENERATOR (XVILLED TROMATCHE PROCESS HON-CONTROL FECTION PETTOWINGS MINIMUM PHASE FEOM VARIABLE GAIN CHAFACTERISTICS FORTGAN BEAD PACKAGE	26 13 14
ASAP		
LAR-11125	ASAP-AN AUTOMATED STATISTICAL ANALYSIS PROGRAM	32
ASTEP .		
#5C-16693	AFTER-ALGORITHMEC SEMULATION TEST AND EVALUATION PROGRAM	57
ASTICHATISM		
*	SERVE-CONTICAL SYSTEMS RAY TRAILING	55
ASTROS		
465-21973	ASTROS-AUTOMATED SHELL THEORY FUR ROTATING STRUCTURES	60
ATROSPHERIC 4	ODEL S	
WFS-21914 WFS-22999	HACENTAL FOR ESSEMBLE TOBIC FEEL HARAFOLDS DESTE DEMENT OF FOUR-DIMENSIFIAL ATMOSPHENIC MODELS (BOREDMIDE)	52 52

AUTOMATIC CONT	/ M (M	
	EgactA-Enhuntatus han EEnsett unchura	43
AUTOSKEM-T		
	AUTOSSEM 1-PUTUMPTIC TURCTROSIC SCHIMATICS	32
AUT(ITEM MIC-10241	AUTOTOW-A CONFLITE PRECEAM FOR AUTOMATED GEOWERN MESHING AND HEAT CONDICTION CALCULATION	**
AVERAGE		
485-10165	SPENSMAN MINI BELTIFLE PARK (MILL (PREESTER, POLICEM	+5
AXIAL COMPRESS		
and the second		
	PRAMEMERS CRITTLE STRUCTURE CRITIMITATION	15
AXIAL FLOW		•
	FERTINAL TRECARM FOR CALCULATING VELECTITIES AND STREAMLINES IN A STACE TO MEADE STREAM SURFACE OF A TANDEM READS TORROWALHING COMMITTEE PROCESSAL FOR A COMMITTEE PROCESSAL FOR ANTAL PLUM COMPORTSSIR OF STOR	,
AXEAL FLOW TU		
19W-13471 1FW-11329	ANALYSIS OF CECHTARY AND DESIGN DOINT DEFENDMENCE OF ARIAL FLOW TURNISHES USING SPECIFIED MERIDICMAL VICINITY DEADLINES.	;
104-11415	condition beaties and selectolized of electrated to arial stem journals	. •
ARISYMMETRIC	AGDIES	
	COMPOSES PRODUCE FERMING MESS GENERATION PROCESS OF AREATING PRINTMETRIC PODIES INCLUDING THE EFFECTS.	45
44-1119; *#-1111	samenessing still GRZ singules, befor viol splengt Stroknasting and Condition and Evidence of Criticality in Versiannismi Condition deficient to Costonial addition talestandists and species on brins wighter in benefitting On enths Committee	100
	CONTAINS COLLEGE FOR CALLIFICATION CONTENTIAL FLOW TO PERPURS IN STATEM THEFT FILERS FORWAY CONTAINS STOLETICAL IN SICK AND STRESS ANALYSTS PREFERAN FOR ADVANCED CONTAINING FILAMENT FORMAY	*4
400-13344 400-13344	ALISTMENT OF CONTROL PROCESS OF COMPRESSIBLE SCRIPS WITH NORTHER OF PRESSIBLE PROPERTIES. **INTIC FLEMENT ANALYSIS OF COMPRESSIBLE SCRIPS WITH NORTHER OF MATERIAL PROPERTIES.	47
ARESYMMETRIC !	PLCW .	
	COMMISSED TECHNISE OF TERMILIST SOSSIBLES ADJUSTED LEVERS COMMITTE PROCESM COMMITTE PROCESM THE LELECTERIST STOPPING SENS IN PRODUCTION SYSTEM 1METS	45
RAL ANCE		
WI 5-251 FF	PANEL-PROCESS FOR ANALYSIS IN ANYLORS ESPECIALISM AND STABILITY	. 46
RALL REARINGS		
144-11513	EVALUATION OF ROTATING INCOMPRESSIBLY EUROTCATED PRESSUREZED THRUST REARTHUS	5.7
RANDIT		
010-11114 1114-1214	MANDET INTROCTERAL MATREA RAPORENTH REDICTEDS CONFORMED UNDORAME ONTIVAL TECH VERSEIN	78 74 74
400 5 6 - 115 61	dayor-castratesal aurola bartatora artification franciar partican activities and season activities and store	,,
HIDIWINA		
01 (-11 34)	AUTOMATER TAKEN BATA PAPRAKATION FOR KASTRAN BAPTH STUDTION OF LARGE SYSTEMS OF LINEAR EQUATIONS WITH MANDER, SYMMETRIC MATRICES ON THE INM SYSTEMATER PS	71
445-11447	Attendation are parely sauthflin elithication	
64RW		
HON-10715	BARN-MELLICORES TURBURATION FINENCE	57
RATCH PROCESS	two	
	COMPUTER UNICERN TO NIECE AND/OR MODISH TANGLAR DATA	74 ;q
RC WRE T		
	ACHRET MELLCOM INCHMATICA RETAILIVAL SYSTEM	:•
REAMS ESUPPIN		
	TOWNS 17 ULTER TOWN ANALYSIS COMPUTER PROGRAM	•
40- 514 40- 514 415- 514	TOPMAN TO COUNTY TOOLE ANALYSIS COMPUTED PROCESSAM SALD ONSAMICA-STRUCTURAL RETURNE ANALYSIS PROCESSAM SALD ONSAMICA-STRUCTURAL RETURNE ANALYSIS PROCESSAM SALD-SALDING TIRSTE ANALYSIS OF TOLES—ON TRADUNTIAL COMPUTE STRUCTURES FORMAN SALDINGS OF PANAMER SALTINGS OLSING PERFORMANCES ANALYSIS	70 52 4 6 8 6

-

BELLOWS		
MFS-1264	I BELLOWS CALCILATION PROCEAD	٠.
BENDING		
MFS-0222 MFS-1262	7 CPEUMS ANALYSIS CPMPLES 2 MELLOGG PIPING ANALYSIS FROGRAM	
BETA LI		
4F5-1505	A RETA ET-POETAC FACINEFRING THERMAL ANALYZER	
REBLÍOGRAPHE		9
f05-024A	1 REBEYS-REAL ENCRAPHER SYSTEM	
646-1144	PERLENCE PRICE CARCINETS SUBSYSTEM	,
ATASYS		•
COS-0248	O BERSYS-MERICCEARCHIC SYSTEM	,
MINARY DIGIT		
ME 2-5103	T DEGITAL THACE DECISTRATECH METHOD RASED LIPON RENARY ROUNDARY MAPS	_
ATOLOGICAL FO	FFCTS	5
45C-141R	S VECTAN 11-CCMEUTER EPEGRAM FOR THE ANALYSIS OF VECTORCARDIDGRAMS	
BEOMEDICAL IN		1
MSC-143 M	VECTAN 11-CCMFUTER PREGRAM FOR THE ANALYSIS OF VECTORCARDINGRAMS	
RIVARIATE AND		11
NPO-10121	FORTERN LY CLERALITARES FOR CONTOUR PLOTTING	
ALKID		3 3
LAR-11414	RENTO-AN TIC ELETTRING SCHEPE WITH SNIPPING CAPABILITY	
PLUNT BOOLES	recognition of the standard that the standard the standar	2 2
LAR-11 744	PERCENT IF FITTENING PARTALING AGENCIAN	
149-11197 149-11197	COMMITTEE BACKERN TO DELEMBER BELCZING DECEMBER 100 TO THE BENEFOLD OF THE MENTO OF	49 1 2
BODIES OF REV		
1 48 -13735 1 48 -11 769 1 48 - 11 769	COMPLIER PROCESS AND STORES AND STORES APPLIES OF RESOLUTION	8.3
4F5-21055 4F5-21073	STRESS ANALYSIS (PTICH KALV-MATER INFACT LEAS ASTROC-LLEAMAN CHELL THERM FOR MODELLE	83
45C-14749		8 T
RODY MEASUREM	AT ENTOLDERS	
450-14386	VECTAN II-COPELTER PROGRAM FOR THE ANALYSIS OF VECTOR CARDIOGRAMS	
BODY-WING AND	TAIL CONFIGURATIONS	16
148-11305	AN IMPROVED PETHED FOR THE AERODYNAMIC ANALYSIS OF MING-RODY-TAIL COMFIGURATIONS IN SURSONIC AND	2
MOUNDARIES		
4FC-17577 MFS-23333	FINDING AN EXTREMEN OF A MOLANES MULTIVARIABLE FUNCTION WITHOUT DETERMINATION OF THE DERIVATIVES DISCHALL IMAGE MECISTRATICS METHOD MASSO UPON BENARY DOWNDARY MAPS.	66
BRIGHTHESS TEM	PFPATURE	58
450-14091	A PROCESS TO STANDARD THE SET OF	
RUCKL THG	The state of the s	53
148-10716	COMMITTE ORDINAL THE STORES WISHARD TO SERITARITY LOADED SHELLS IN SEVELUTION	
[4R -]] 169 [4R -]] 604	-complites denotes for states of the tight analysis of laminated long foresties of general shells it sevilution for language for instancing and compared complites on process for instancing analysis of laminated long flates subjected to complete	53
45C-12706	TAPLANE LORDS CAPP-COMPRESSION ALLOMABLE FLITTING SOLUTIONS	. 53
BUCLAPZ	The state of the s	87
1 44-11695	RUCLAPZ-A COMPUTER PREGRAM FIR INSTABILITY ANALYSIS IS LAMINATED LING DIATES CHARECTED IN	

ORIGINAL PAGE IS OF POOR QUALITY

BUDGET ING		
COS-02540	EXTLE PEXISTINES - PINERAL ENGINATION INVESTMENT OPTIMIZATION AND RESCURCE ESTIMATION COMPUTER PROGRAM.	51
MF 5-18141	LABORN-LABORATORY JOS CONTACE PROGRAM	• 3
BUT FER STORAGE		
148-11414	RENEO-AN TIO BUTFERING SCHENE WITH SKEPPING CAPABILITY	. 2.1
BUT ENEADS		
000-00041	MEOSHEP SECTION EFFICA FOR NAVAL SHIPS	7 7
CALCULATOAS		
[AR-11698	PREGRAM FOR INTERFACENC & POWLETT-PACKARD MODEL 9830 CALCURATOR WITH A SEMETT-PACKARD MODEL 5401 9 MULTICHANNEL ANALYZER	27
CALICO		
650-11657	CALICO-CAPETAL ASSETS LOCATION ENVENTORY CONTROL	39
CALORIC REGUIR	EPENTS	
MPD-13206	MUTRITIONAL EVALUATION OF CIETS	15
CAMERAS		
149-11073	CONVERT-TECHNIQUE AND COPPUTER PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DENSIFY WARRATIONS	56
CANALS		
	QUAL 1-SIMULATION OF MATER QUALITY IN STREAMS AND CANALS	53
	DOSAG 1-SIMULATION OF WATER QUALITY IN STREAMS AND CANALS	54
CANS		
656-10404	CANS-COMPUTER ASSISTED RETACRE SCHEDILING SYSTEM	3 0
CANTILEVER BEA	URS	
	TOWER 12-CUTET TOWER ANALYSIS COMPUTER PROGRAM COMPUTER PROCESM FOR CALCULATING CRITICAL SPEEDS OF ROTATING SHAFTS	F 7
CAPR		
HSC-12706	CAPR-COMPRESSION ALLOWABLE FLOTTING ROUTINE	97
CAPS		
	CAPS-SCURCE TECK COMPRESSION AND UPDATE PROGRAM	22
CARCONYDRATES		
NPO-13706	MUTRITIONAL (VALUATION OF CIETS	15
	MOINTILLIANT (ANCOURTER TE CIST)	
CARRON	and the contract of the contra	
HSC-19494	REINFTREED CEPPERA-CARACA PASS LOSS	59
CARDIDGRAMS		
CGS-02450 CGS-02451	VETERANS ADMINISTRATION AUTOMATED ECG ANALYSES SYSTEM, RELEASE 3,6 LTC 1000 SERIES VERSION VETERANS ADMINISTRATION AUTOMATED ECG ANALYSES SYSTEM, RELEASE3, TO VARIAN 73 VERSION	13
CARDIDGRAPHY		
COS-02450 COS-02451	VETERANS ADMINISTRATION AUTOMATED ECG ANALYSIS SYSTEM, RELEASE 3.6 CDC 3000 SERIES VERSION VETERANS ADMINISTRATION AUTOMATED ECG ANALYSIS SYSTEM, RELEASE3.5 VARIAN TO VERSION	13
CARGO		
MSC-14116	LOGISTICS RESUPPLY COMPUTED PROGRAM	• •
CARTESTAN COOF	POINATES	
MSC-17011	GEOMFTRY PROCESSON MESH TOPOLOGY AND NODAL POINT GENERATOR	2 7
CAVITATION FLO	ov	
LFW-11579	FORTRAM FROCESMS FOR THE CESTON OF LIQUID TO LIQUID JET PUMPS	50
CENTRAL PROCES	SSING UNITS	
MSC-14815	HP-65 ENULATOR	2+
CENTRIFUGAL SO	DAMESSORS	
1 E W-11 795		5

i fw-lia	59 CFNA-COMPRESSIBLE FLOW RETSORK ANALYSIS COMPUTER PROGRAM	
CFT	The same of the sa	
NPO-116	SE CFT-MULTE-DEPENSIONAL COPPLEX FOLMER TRANSFORM	
CHAREL	TO THE STATE OF THE STATE OF THE TRANSFORM	
f 4M-110	19 CHANEL-FORTRAN PROGRAM FOR GUASI-THREE-DIMENSIONAL CALCULATION OF SURFACE VELOCITIES AND CHOCING FLOW FOR TURECPACHINE PLACE ROMS	
CHARCE	The second of th	
PISC-1756	• •	
	A DIGITAL ANDREAS CHARGE	
CHTIBIEL LEGI		
LFW-1185	9 CFAA-COMPRESSIBLE FLOW ACTWORK AVALYSES COMPUTER PROGRAM	
CHARACTER RE	TOCALTION	
650-1178	7 CSS-CHARACTER STRING SCANNER	
CHARRING		
1 FW-11 85	4 APM4_100000000 4	
CHECKOUT	4 ACMA-AFRETHEFF CHARBING MATERIALS ABLATION COMPUTER PROGRAM	
COS-0221: GSC-1149	FLOWCHARTER- PROGRAM FOR PRODUCING FLOW CHARTS OF FORTRAM SOURCE DECKS, TEM-350 VERSION	
CS C-1193	SIGPAC-SIGNIFICANCE ARTHMETIC EXPERIMENTAL PACAGE. STRUMACS-OSYTED ASSEMBLY LANGUAGE STRUCTURED PROGRAPHING MACROS	
CHERICAL ANAL	LYSIS	
NPO-11961	THEFE BET MASS SPECTRAL SEARCH PROGRAM	
CHERICAL ELE		1
********	ACE-AEROTHERP CHEMICAL EQUILIBRIUM COMPUTER PROGRAM	
CHENICAL FOUL		
l FW-11722 LFH-11743	ACE-AEROTHER® CHEMICAL ECUILIRRIUM COMPUTER PROCRAM COMPUTER PROCRAM FOR CALQUERTION OF COMPUTER CHEMICAL FOULLIRRIUM COMPOSITIONS, ROCKET PERFORMANCE, INCIDENT AND REFLECTED SECCKS, AND CHARMAN-JOUGUET CETONALIONS	
CHEPICAL REAC		•
L FM-11467	GENERAL CHEMICAL KING THE COMPLETE	
LEW-11 722	GENERAL CHEMICAL RIMETICS COMPUTER PROGRAM FOR STATIC AND FLOW REACTIONS WITH APPLICATION TO COMMUNITION LAND SHOCK TURE RIMETICS	1
	ACE-AFROTHER CHIMICAL FOULLINNIUM COMPUTER PROGRAM	1
CHOKES TRESTR		•
LFW-11635	CHANEL-FORTHER PROGRAM FOR GIAST-THREE-DIMENSIONAL CALCULATION OF SURFACE VELOCITIES AND CHOKING	
CIM	A PARTICIPATE DESIGNATION OF THE PROPERTY OF T	
	419.444	
	CIM-COST INFORMATION PANAGEPENT COMPUTER PROGRAM	
CIRCUIT BOARDS		. •
G5C-11947	PHEZILE-COMPLIER AIDED DESIGN OF PRINTED CIRCUIT ARTHUR.	
CIRCUIT DIAGRA		3.
GSC-11947	PUZZLE-COMPLIER AIDED DESIGN OF PRINTED CIPCUIT ARTHORY	
65C-11948 4PO-11382	AUTOSKEM 1-ALTOMATIC CLETARNIC SCHEMATICS MERE CHAIN PROCRAM, UNIVAC 1108 VERSION	32
IRCUITS	A CAMPAGE AND A MERSION	32
	ASAP-AN FUTCHATEC STATISTICAL ANALYSIS PROGRAM STICAP-LIMEAN CIRCUIT ANALYSIS PROGRAM WITH STIFF SYSTEMS CAPABILITY DESIGN OF PICECYSTRY COMPANYS OF STATEMENTS OF STATEME	
LEW-10667	FFAP-SISCEPTATE CENTER OF COMPANY OF CHAPTER	32 33
452-11046	FCAP-ELECTRONICS CLACULT APALYSIS PROGRAM (COC VERSION)	33 34
MSC-17487	TOISPANCE ANALYSIS OF FLECTRONE STRONG POR TRANSIENT ANALYSIS OF FLECTRONE STRONG	34
MPO-11412	MIRE CHIEF AFCORAM. UNIVAC ILON VERSION	34 35
NPO-11494	MTRAC-COMPLITE PROGRAM FOR ANALYSIS OF CERCUITS INCLUDING MAGNETIC COMES	35
1ACUS		15
4FS-15002	CERCUS-A DIGITAL COMPLTER FROSRAM FOR TRANSFENT ANALYSIS OF ELECTRONIC CERCULTS	
LIMATOLOGY	AUTOMOSE AND AUTOMOST OF EFECTRONIC CIACHILE	34
KSC-10425	SSCOL-STATISTICAL SUMMARY OF CLINATOLOGICAL DATA	
	THE STATE OF THE S	52

CODEM	
LAR-10999	COTER-CLOCK CENHON NON-EXECUIANCE STATEMENT GENERATOR
COSTNE	
	STRCMACS-05/740 ASSEMBLY LANGUAGE STRUCTUPED PROGRAMMING MACROS BOC-INTERNAL DISCHMENTATION GENERATOR
COEFFICIENTS	
MFS-18565	FORTER-FCHTRAN M SUBROUTINE SUBPROGRAM
COLCR	
NPO-19603	POLOP-FORTRAN OPTICAL LEAS DESIGN PROGRAM
CULUMNS ESUPPI	PRTS)
MFS-02227	COLUMN ANALYSES COMPLEX
COMBUSTICH	
L EN-11467	GENERAL CHENICAL KINETICS COMPUTER PROGRAM FOR STATIC AND FLOW PEACTIONS WITH APPLICATION FO CCHRUSTICM AND SMOCK TUBE REMETICS
COMPSLERS	
	EXTRAN-EXPRESSION TRANSLATOR CODER-BLOCK COMMON NON-EXECUTABLE STATEMENT GENERATOR
COMPLEX SYSTE	15
MFS-19302	SAMECS-STRUCTUREL AMALYSIS METHOD FOR EVALUATING COMPLEX STRUCTURES
COMPONENT REL	ACILITY
MFS-[45]3 MFS-24034	SFE-SYSTEMS EFFECTIVENESS EVALUATION CCMPUTER PROGRAM RRM-RELIABILITY AMALYSIS MOREL APROCT-AFPORTICAPENT/PRECICTION ERSINV-RELIABILITY GOAL STATUS
COMPONENTS	
MFS-24321	FEUP-ENGINEEPING CRETICAL CCHPOMENTS LISTING
COMPOSITE MAT	ERTALS
	REINFORCED CARRON-CARRON MASS LOSS CONTANK-STRUCTURAL DESIGN AND STRESS ANALYSIS PROGRAM FOR ADVANCED COMPOSITE FILAMENT-WOUND AXISYMMETRIC FRESSURF VESSELS
COMPRESSIBLE	ECANDARY LAYER
144-10950	COMPRESSIBLE LAMINAM OR TURBULENT NOWS INILAR BOUNDARY LAYERS COMPUTER PROGRAM
COMPRESSIBLE	rica
LAR-11247 LEW-10789	
LFW-11033 LFW-11859 MFS-00443 MFS-14683 MCC-14178	INVESTIGATION OF ISCTIFERAL COMPRESSIBLE FLOW ACROSS A ROTATING SEALING DAM CFNA-COMPRESSIBLE FLOW ACTACRE ANALYSIS COMPUTER PROGRAM SOLUTION OF CEMPRESSIBLE FLOWS IN PIPING SYSTEMS
COMPRESSIBLE	
	MUMERICAL SOLUTION OF TRANSONIC FLOW IN A CONVERGENT-DIVERGENT MOIZLE
COMPRESSING	
	CFNA-COMPRESSIBLE FLOW ACTWORK ANALYSIS COMPUTER PROGRAM
COMPRESSION L	
	CAPR-COMPRESSION ALLOWARLE PLOTTING ROUTINE
COMPRESSIVE S	
	CAPR-COMPRESSION ALLOWABLE PLOTTING ROUTINE
COMPRESSOR &	
	COMPUTER PROCEDURE FOR AREAL FLOW COMPRESSOR DESIGN
COMPRESSOR EF	
	PROGRAM FOR CALCULATING TOTAL-EFFICIENCY SPECIFIC-SPEED CHARACTERISTICS OF CENTRIFUGAL COMPRESSORS
COMPRESSOR RO	
	CONFUTER PROCEAMS FOR AREAL FLOW COMPRESSOR DESIGN
	PROGRAM FOR CALCULATING TOTAL-EFFICIENCY SPECIFIC-SPEED CHARACTERISTICS OF CENTRIFICAL COMPRESSORS

COMPRESSO	as	
L FW-1	0765 CCPPUTER PROGRAPS FOR ANTAL FLOW COPPRESSON DESIGN	3
COMPUTER	GRAPHICS	
015-0	2219 FLOWCHARTER-# PRICRAM FCP PRODUCING FLOW CHAPTS OF FORTPAN SITURCE DECKS, IBM-363 VERSION 3053 GRIDZO-IFFS-THE CHMINSIONAL GRID GENERATOR AND TERMINAL CONTROL SYSTEM OF THE INTERACTIVE GRAPHICS FINITE ELFRENT SYSTEM	- 19 79
KSC-1	0450 FFCP1-FORTRAN FLOW CHART FREGRAM	24
	0877 GENERALIZED DICITAL CONTOURING PROGRAM 0857 A SET OF FORTERN IN SUBPOLITIES FOR GENERATING PRINTED PLOTS	. 25
wf5-E	5107 ALGORITHM FOR MFCLCING THE NUMBER OF REQUIRED POINTS IN A GRAPHICAL DATA SET	27
49C-1	7371 GETMETRY PROCESSOR, MESH TORMOGY AND WOOL POINT GENERATOR 0127 FORTRAM BY SERFOLTINES FOR CONTOUR PLOTTING	67 30
COMPUTER		,,
000-0	0037 NGPSS-NACC GENERAL PUPPOSC SIMULATION SYSTEM FOR CCC 6200 SERIES COMPUTERS	38
CONFUTER	PROGRAMM ING	
	1333 SDS 900 FERES SASAO AUTOFLOW PREPRICESSOR SYSTEM 1331 DDP 24 SERIES SASAO AUTOFLOW PREPRICESSOR SYSTEM	22
65C-1	1912 CPC (300C SF0115 S/360 PUTCHLOW PREPRICESSOR TYPER	22
	1333 INIVAC 11CH 1736C ALTOFICH PREPROCESSOR SYSTEM	22
	1918 STREMACS-OS/160 ASSEMBLY LANGUAGE STRUCTURED PROGRAMMING MACROS OPRO DOC-INTERNAL DECUMENTATION CEMERATOR	23
	1416 REGIO-AN 1/0 PUFFEING SCHEW MITH SKIPPING CAPABILITY	75 27
COMPUTER		
1.491	1176 ALTELIN-AUTOMATIC COMPUTER SUMPRIGRAM SELECTION FROM APPLICATION PROGRAM EIRBARIES	••
(42-5	1326 ODINFR-OPTIMAL DESIGN INTEGRATION EXECUTIVE PROGRAM	26 26
# \$C = 1	7567 CHANGE-FERTRAN IN DIGITAL FROMAN CHANGE	29
COMPUTER	STORAGE DEVICES	
[48-]	0454 CONFR-MITCK CEPHEN NON-EXECUTABLE STATEMENT GENERATOR	. 26
COMPUTER	SYSTEMS PROGRAMS	
_cns~c	7241 SLACMON-BLAC SOFTWARE MENTION, VERSION 2.2	17
cus-		20
675-1	2570 FYTRAN-EXPRESSION TRANSLATIR 0779 MILTIPLE UTILITY COPPLIER PROSPAN	31
t 44-1	1724 OF INTER-POTTING TESTON ENTERNATION EXECUTIVE PROGRAM	25 26
COMPUTER	TECHNIQUES	
ב-מרק	7034 GENERAL PUMPCSE CVERLAY LOACER FOR COC 6000 SEPLEN COMPUTERS	. 22
	1918 STREMACS-CS/3en assembly Language Structuret Procedurating Machage	23
	2778 MILTERE LITELETY COMPLTER PRICALM	25
[42-1	7947 DOC-INTERNAL OFCUMENTALICK CENERATOR	26
₩< C - 1	1414 PLRID-AN 170 PLFFFRING SCHEPF WITH SRIFPING CAFAPILITY 4147 UHELP-UNIVERSITY OF HOLSTON FASY LINGAR PRIGRAPHING SYSTEM	27 73
	ZED DESIGN	• •
110-1	2478 STRUCTURAL SYNTHESIS OF A STIFFFNED CYLINGER	
148-1		80
LFW-1	3299 PRINTE SUPPLIFE LSING HIGH FREQUENCY MODULES	ii
EFW-		3
r t m - 1	1929 ANALYSIS OF CECHETRY AND DESIGN POINT PERFORMANCE OF ARIAL FLOW TURBINES USING SPECIFIED MIRIDIONAL VELOCITY GRADIENTS	•
MF 5 = 2 YPO = 1		34 57
	ZED STRULATION	31
	1512 GREMEN-GODDARD RESEARCH AND ENGINEERING WANAGEMENT EXERCISE SIMULATION SYSTEM	30
me 5 - 1	5002 CIRCUS-A DIGITAL COMPLETER PROSERM FOR TRANSIENT ANALYSIS OF ELECTRONIC CIRCUITS	34
₩ 5-2	IORZ SIMPLIFIED FILIC SYSTEM THERMAL ANALYSIS	*3
	1965 METHOD FOR NOALTHEAP EXPONENTIAL REGRESSION ANALYSIS 2672 MARSYAS-MARSHALL SYSTEM FOR AFROSPACE SIMULATION	. 72 43
COMPUTERS		

NPO-11943 CONTANK-STRUCTURAL DESIGN AND STRESS ANALYSIS PROGRAM FOR ADVANCED COMPOSITE FILAMENT-MOUND ARTSYMMETRIC PRESSURE VESSELS

CENTRAL TRANSFER FOR THE PROGRAM FOR THE PROGR

EAR-11801 CHEMICAL EQUILIBRIUM OF AREATION MATERIALS INCLUDING CONDENSED SPECIES

MES-22664 CEMPUTER UTSLIZATION PRESICTION HODEL

CONTANK

COMPENS ING

CONDUCTIVE HEAT TRANSFER

COMICAL SHELLS	94
MFS-17217 STRESS ANALYSIS OF PELLEVELLE SPRINGS PHOGRAM	
COMMIN	56
ARC-10835 CCAMIN-A FORTEAN PPECRAM FOR CONSTRAINED FUNCTION MINIMIZATION	
CONSTAT	29
MSC-17484 CONSTAT-A COPPRESENSIVE PROGRAM FOR TEXTUAL CONCORDINGES AND STATISTICS	
CONSTRAINTS	43
MES-27997 A COMPUTERIZED SCRUTTON OF THE REPNER-TREGOE METHOD ALGORISM	
CONTINUUS	11
HPO-11959 ELASE-COMPUTER PROGRAM FOR LINEAR EQUILIPATION PROBLEMS OF STRUCTURES	
CONTOURS	,
ARC-10ARD AIRCRAFT WOISE SCURCE ARC CONTOUR ESTIMATION COMPUTER PROGRAM LAR-10RTZ GENERALIZED CICITAL CENTURING PROGRAM NPO-10127 FORTRAN IV SLEROLTINES FOR CONTOUR FLOTTING	30
CONTROL	37
LEW-1255 DIGITAL PROGRAM FOR SCLVING THE LIMFAR STOCHASTEC OFFINAL CONTROL AND ESTIMATION PROBLEM LIMM VERSIONS WES-22672 WERSYNS-MARKENSTEE STYLE STRUCKERS SIMULATION	43
CONTROL EQUIPMENT GSC-11976 AUTCHIS" LIBM 36C VERSICAL	31
CONTROL THEORY ARC-10616 VESP-VARIABLE CIPPASICA AUTOMATIC SYNTHES'S PACCHAM ARC-10616 VESP-VARIABLE CIPPASICA AUTOMATIC SYNTHES'S PACCHAM ARC-10616 VESP-VARIABLE CIPPASICA AUTOMATIC SYNTHESIS STECHASTIC COTTINAL CONTROL AND ESTIMATION PROBLEM LIBMANIAN STECHASTIC CONTROL AND ESTIMATION PROBLEM STECHASTIC CONTROL CO	31 37
ARC-10616 VESP-VARIABLE CIPENSICA AUTOMATIC SYNTHES'S PROCHAM LEW-12505 STIGITAL PROCESS OF SOLVING THE LINEAR STOCMASTIC OPTIMAL CONTROL AND ESTIMATION PROBLEM LINE VERSIONS	
CONVECTIVE HEAT TRANSFER	73
LEW-12110 REGENERATIVE CECLING CESIGN/ANALVSIS CEMPUTER REPEARALVSIS OF PLANE UR ARISYMMETRIC BIDIES UCC-1004 COMPUTER PROGRAM FOR THE STEADY-STATE TEMPERATURE ANALVSIS OF PLANE UR ARISYMMETRIC BIDIES	45
COMPERGENCE	74
NPT-10614 VERGE-A DIGITAL COMPLIER SEMBUTTINE TO ACCELERATE THE CONVERGENCE OF ITERATIVE PROCESSES	
CONVERGENT-DIVERGENT MOIZLES	50
NPO-LINGS MIMERICAL SOLUTION OF TRANSPILE FLOW IN A CONVERCENT-DEVERGENT NOZZLE	
CONVERSION	. 20
COS-02510 FORTRAM ANALYZER GSC-11399 FORTAM-A CENEFALIZEC SURTRAM TAPE CONVERSION PROGRAM	22
COMMENT	56
LAR-11473 CCHYERI-TECHNICUF AND COPPUTER PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DENSITY VARIATIONS	
COMMOLUTION INTEGRALS	73
MSC-19378 ANNITION CONVOLUTION COMPUTER PRICAM FOR LOST RESK ANALYSES NPO-11649 REFLI-ONE OLDERNICKAL REAL EQURIER TRANSFORM NPO-11641 CET-MULTI-DIPERSIONAL COMPLEX FOLDITE TRANSFORM	74 75
COOLANTS	
LEW-1211) REGENERATIVE COOLING CESIGN/ANALYSIS COMPUTER ROCGRAM	93
COORDINATES	
EFW-13482 PLOT3D-A PACRACE OF FORTRAN SJBPADGRAMS TO DRAW THREE DEMENSIONAL SURFACES WES-72484 POINT TRANSFORMATION-CREMICRAPHIC TO PERSPECTIVE, FORTRAN W VERSION FOR 360 SYSTEM USE WES-72488 DEVELOMENT OF FORM-CREMICRAPHIC MOCELS INCAL MIDDE	21 10 53
CORF STORAGE	
MPG-13322 MAYEFRONT-STRECTERAL SIZEFRESS METRIC WAVE FRONT PESEQUENCING PROGRAM	6.
CORRELATION COEFFICIENTS	
MAC-10164 SPEARMAN BHO BLETTPLE HAND CROER COPRELATION PROGRAM	6,
COST AMALYSIS	7
MSC-1937A ACRITICA CONVOLLTICA COMPLIER PROGRAM FOR COST PISK ANALYSIS NPO-11973 FORTRAN MANPONER ACCOUNTING PROGRAM	4

COZ	T ESTIMATES		
		EFILE/EXIST/IPIS-MINERAL EXPLORATION INVESTMENT OPTIMIZATION AND PESOURCE ESTIMATION COMPUTER PROGRAM	51
	LAR-11887 MSC-17556	LRC-MASA PERT TIME 141 CIM-COST INFERMATION MANAGEMENT COMMUTER PROGRAM	44
COST	T REDUCTION		
	MSC-17556	CIN-COST INFOPRATION PANAGEFENT COMPUTER PROGRAM	44
COST	75		
	MSC-17556	CIM-COST INFOPMATION PANACEMENT COMPUTER PROGRAM	44
COU	ETERS		
	MF S-22401	COMPUTERIZED LOCIC DESIGN OF DIGITAL CIRCUITS	. 30
COV	ARTANCE		
	LEW-12505	DIGITAL PROGRAP FOR SCLVING THE LINEAR STOCHASTIC OPTIMAL CONTROL AND ESTIMATION PROBLEM (18R VERSION)	. 31
CPH			
7		CPM-CRITICAL PATH METHOD	36
reti	TICAL PATH		
		CPM-CRITICAL PATH METHOD	34
CRI	TICAL VELOC		
		COMPUTER PROGRAM FOR CALCULATING CRITICAL SPEEDS OF RETATING SHAFTS	60
CRO	ZE RECLICAS		
	MF3-21970	ASTROS-AUTOMATED SHELL THEORY FOR ROTATING STPUCTURES	86
CRY	OGENICS		
	DOD-00025 DOD-00026 DOD-00027	MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM (1BM 7094 VERSION) MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM IUNIVAC 1108 VERSION) MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM ICCC 6000 SEXIES VERSION) MEL 40-PIPINE FLEXIBILITY ANALYSIS PROGRAM KEL 40-PIPINE ANALYSIS PROGRAM	76 76 75 78
css			
	GSC-11787	CSS-CHARACTER STRING SCANNER	21
CUR	VE FITTING		
	70000-0007	STHTAB-SUBROUTINE FOR THE THERMODYNAMIC PROPERTIES OF STEAM AND WATER	91
	LEW-10917 LFW-11062	FORTRAN PROGRAM FOR SPLINE FIT CURVE RAPIER-FORTRAN IV PROGRAM FOR MULTIPLE LIMEAR REGRESSION ANALYSIS PROVIDING INTERNALLY EVALUATED REMCDELING	6 5 6 6
	LEW-11651 LEW-11842 MF5-22136 NPO-10786	FITLOS—FERTRAN PECGRAM FOR FITTING LON-ORDER POLYNOMIAL SPLINES BY THE METHOD OF LEAST SQUARES NEWARP—AN IMPROVED MULTIPLE LINEAR REGRESSION AND DATA ANALYSIS COMPUTED PROGRAM THE SELECTION OF APPROXIMATING FUNCTIONS FOR TABULATED NUMERICAL DATA SPLINT—PARABOLIC SPLINE INTERPOLATION SUBROUTINE	69
CUR	VED PARELS		
		GENERALIZED CIGITAL CENTEURING PROGRAM BUCLAPZ-A COMPUTER PREGRAM FOR INSTABILITY ANALYSIS OF LAMINATED LONG PLATES SUBJECTED TO COMBINED INPLANE LOADS	2 5 8 3
CUR	VED SURFACE	s	
	LAR-11696	BUCLAP2-A CEPPUTER PROGRAM FOR INSTABILITY ANALYSIS OF LAMINATED LONG PLATES SUBJECTED TO COMBINED IMPLANE LOADS	8 3
CAC	LES		
	COS-02530	TIDEDA-TIME DEPENDENT DATA ANALYZER	66
CYC	LIC LOADS		
	MSC-13995	FRACTURE MECHANICS EVALLATION OF TI-6A1-4V PRESSURE VESSELS	81
CYL	INDRICAL BD	DIES	
	LAR-10473	STRUCTURAL SYNTHESIS OF A STIFFENED CYLINDER	80
DAM			٠,٠
		INVESTIGATION OF ISCTIFFMAL COMPRESSIBLE FLOW ACROSS & ROTATING SEALING DAM	59
Dat	A BASES		
		MULTIPLE UTILITY COPPLTER PROGRAM	2 5
	L 4R-10459	CODER-PLOCK COMMON NON-EYECUTABLE STATEMENT GENERATOR DEVELOPMENT OF FOUR-DIMENSIONAL ATMOSPHERIC MODELS (MOMEDHIDE)	20

Sink !

...

ومشماعيناي

DATA BASES		
MSC-17446	FMEA-FAILURE MCCE AND EFFECTS ANALYSIS INPUT/OUTPUT PROGRAM	
DATA COMPERSI		
	CAPS-SCUPCE EFER COMPRESSION AND UPDATE PROGRAM	
DATA CONVERTE		
. PRO-00017	NIPS-MATICARE MILITARY COMPAND INFORMATION PROCESSING SYSTEM, SYSTEM 560 FORMATTED FILE SYSTEM MINOR FALLATOR	\$
DATA CORRELAT	I on	
480-10165	FARMAN AND PLETIPLE BANK CROEK COPRELATION PROGRAM	•
NPD-11963	HRTE BET MASS SPECTAM SEARCH PROGRAM	- 1
DATA HEMSER!		
000-00017	HIPS-NATIONAL MILITARY COMMAND INFORMATION PROCESSING SYSTEM. SYSTEM 360 FORMATTED FILE SYSTEM	2
51411-322 45461-469	SCINDER-CS/160 SYSTEM GENERATION CROSS REFERENCE INDEX ROMRET-RELECTMM INFORMATION RETRIEVAL SYSTEM	
\$\$451-PDH	RECONSTERS-REMOTE CONSOLE AND SCIENTIFIC . TECHNICAL INFORMATION MODULAR SYSTEM	
# 4C - 10 b l e	apris-autorated eata paragement in capation system	
K5C-10A17	AFT-REMOVE FILE INQUIRY SYSTEM ALKIN-AN 170 EURFERING SCHEPE WITH SKIPPING CAPARILITY	3
445-18729	OSAM-VARIABLE LINGIN IMPLIACUIT ROUTING LAPARILLIA	3
DATA PROCESSI		
FIF 5 - 1 N & R V	INSTRUMENTATION RELIABILITY ANALYSIS PROGRAM	30
DATA REDUCTION		
650-11039	AUTEMATED THREE CATA PREPARATION FOR NASTRAN	
656-11-44	ERPS-SQUECE PER COMPRESSEN AND UPDATE PROGRAM	7
144-10444	CODER-BLECK CEMBLE REPRESENTED STATEMENT GENERATOR	21
L FW-12285	SOME PROPIESION SYSTEM ROISE DATA MANDEING CONVENTIONS AND COMPUTER PROGRAMS USED AT THE LEWIS RESEARCH CENTER	
MF 5-15107	ALGORITHM FOR RETUCING THE NUMBER OF REQUIRED POINTS IN A GRAPHICAL DATA SET	21
456-11440	ALGORITHM FOR MATRIX PARIMITISM REDUCTION	. 1
#4C-11414	PROCRAM TO RECUCE THE SIZE OF STRUCTURAL MATRICES	Pi
DATA RETRIEVAL		
650-11952	REBLEDGRAPHIC PRETRICTS SERSYSTEM	2
PPAD1-PCH	RECONSTENS-PERCE CONSCEE AND SCIENTIFIC + TECHNICAL ENFORMATION MODULAR SYSTEM ADMIS-AUTOMATED CATA MANAGEMENT INFORMATION SYSTEM	2
		•
DATA SMOOTHING		
M50-13386	SPEINT-PARAPOLIC SPEINE INTERPOLATION SUNROUTINE	7-
DATA STORAGE		
GSC-11945	CAPS-SOURCE PECK COMPRESSION AND UPDATE PROCESS	. 2.
HON-13474	RCHRET-BELLCOPH INFORMATION RETRIEVAL SYSTEM	2
HON-10tas	RECONSTINS-PERCIE CONSELE AND SCIENTIFIC & TECHNICAL INFORMATION MIDDIAN SYSTEM	. 2
DATA SYSTEMS		
010-02017	NIPS-NATIONAL MILITARY COMPANY INFORMATION PROCESSING SYSTEM, SYSTEM SAY FORMATTED FILE SYSTEM	2
K5C-12419	1 TPT1-14CRANCE THEE POINT INTERPOLATION COMPUTER PROGRAM	
mt 2-18157	Ozem-Assisure Figgs intriviation unities	21
DFC 15 LONS		
MF 5-19747	SPECIAL PROGRAM FOR DISCOUNTED CASH FLOW/RATE OF RETURN EVALUATIONS	•:
DECOMPOSITION		
11n-11u-e	MARGOCHE RETURNO SATISTALS AREALS (OMPUTER PERGENCE MARGORIA MARGOCHE PAGENTA	. •
DEFE ECT 109		
	COLUMN ANALYSIS (CMPLFE	. 90
#15-14217	STRESS ANALYSIS OF RELEIVILE SPRINGS PROCEPU	8
DENDRO		
MFS-13127	DENORD-SOLUTION OF DIFFERENTIAL EQUATIONS USING THE NORDSLECK METHOD	. 1
DEPENDENT YES	IARES .	
	PAP-PAPANTTRIC ANALYSIS PREGRAM	6
6 t 4 - 1 0 4 1 9 W 5 - 1 2 9 FL	FORTRAN IN PROGRAM FOR SYMPOLIC SOLUTION OF UP TO 20 SIMULTANEOUS EQUATIONS REACAM-SUPPOLITEE TO SOLVE OFFERENTIAL EQUATIONS	6
DEBBEC 14710m	The state of the s	,

SPECIAL PROGRAM FOR DISCOUNTED CASH FLOW/RATE OF PETIMA EVALUATIONS

DERIVATION			
	FINDING AN EPTREPUN OF A ROUNDED MULTIVARIABLE FUNCTION OF DENDRO-SCLUTICA OF DIFFERENTIAL EQUATIONS USING THE MORD		6 (7)
DES ICH			
EEM-11635	CHANEL-FORTRIA PROGRAM FOR QUASI-THREE-DIMENSIONAL CALCUI FLOW FOR TUMPEMACHINE PLADE ROWS	LATION OF SURFACE VELOCITIES AND CHOKING	•
DESIGN ANALYS	IS		
LEW-10299	POWER SUPPLIES USING HIGH FREQUENCY MODULES		11
DETECTION			
NPD-11692	ATREDU-MIND TRAJECTORY TRACING FOR AIR POLIUTION STUDIES		- 51
DETONATION			
LEH-11740	COMPUTER PROGRAM FOR CALCULATION OF COMPLEX CHEMICAL FOU INCIDENT AND REFLECTED SHOCKS, AND CHAPMAN-GOUGHT DETON		. 11
DIAGRAMS			
	FLOWCHARTER-# PROGRAM FOR PRODUCING FLOW CHARTS OF FORTR. AUTOSKEM 1-#UTCMFTTC FLECTRONIC SCHEMATICS	AN SCRIPCE CECKS, 18N-359 VERSION	19 5 32
DIFTS			
	NETABOLIC PALANCE ANALYSIS PROGRAM NUTRITIONAL ENALLATION OF DIETS		14 15
DIFFERENCES	the production of the second second		
MFS-12981	READAM-SURFOLTIME TO SCLUE DIFFERENTIAL EQUATIONS		71
DIFFERENTIAL (CALCULUS		
	NUMING-RUMERICAL INTECRATION BY SAUSSIAN QUADRATURE FORTRAN FROGRAM FOR SPLIKE FIT CURVE		67
DIFFERENTIAL.	EQUATIONS		
HON-10735 LFW-11467 MFS-00465 MFS-12981 MFS-13127 MFS-15002 MFS-21701	MIMING-HIMBERICAL INTEGRATION BY GAUSSIAN QUADRATURE ARN-RELECTIVES APPROXIDEATION LINRARY GENERAL CHEMICAL RINGTICS COMPUTER PROGRAM FOR STATIC AN COMMUNITION AND SHOCK TUPE KINETICS AMINT-ARDERS POLITION INTEGRATION SURROUTINE REATH SURROUTINE TO SOLVE DIFFERENTIAL EQUATIONS DENORMO-SCHULLOR OF CIPEDENTIAL EQUATIONS USING THE NORD CIRCUS-A DIGITAL COMPUTER PROGRAM FOR TRANSIENT ANALYSIS MARVES — MARSHALL SHIELL FROLDERFRIMS SIMULATION SYSTEM MARYS—MARSHALL SHIELL FROLDEFRIMS SIMULATION SYSTEM	STECK METHOD	61 57 11 76 71 34 43
DIFFERENTIAL 1	THERMAL ANALYSIS		
MSC-13805	SINCA 3G-SYSTEPS IMPROVED NUMERICAL DIFFERENCING ANALYZE	L CUNTAC 1100 SERIES VERSIONS	i
DIFFRACTION			
FRC-10017	CSRTL-OPTICAL SYSTEMS RAY TRACING		. 55
DIFFUSE RADIA	T 10N		
#£ 2-31 0 12	RAVFAC-RADIATICA VIEW FACTER PROGRAM		73
DIFFUSERS			
LEW-11796	FORTRAN PROGRAM FOR CALCULATING VELOCITIES IN THE MERIDI	THAT PEANE OF A TURBOMATHENE	•
DIGITAL CORPU	reas .		
H2C-14141	FORTRAN PEAC FACHAGE		51
DIGITAL DATA			
	GENERALIZED CICITAL CONTOURING PROGRAM DIGITAL IMACE REGISTRATION PETHOD BASED UPON BINARY ROUN	DARY MAPS	21 50
DIGITAL FILTE	es .		
	RFT1-DNE DIMENSICHAL REAL FOURIER TRANSFORM' CFT-MULT1-C1PERSIONAL COMPLEX FOURIER TRANSFORM	ORIGINAL PAGE IS	74
DIGITAL INTEC	RATORS	OF POOR QUALITY	
mf \$-27401	COMPUTERIZED LOCIC DESIGN OF DIGITAL CIRCUITS		34
DIGITAL SIRUL	ATION		
	MGPSS-NATC GENERAL PUPPOSE SIMULATION SYSTEM FOR COL CON-		33

CEME	MS LONS		
	LFW-10482 WF 5-22818	PLOTION-A PACKACE OF FORTRAN SURPADGRAMS TO DRAW THREE DIMENSIONAL SURFACES DEVELOPMENT CV FOUR-DIMENSIONAL ATMOSPHERIC MODELS (MORLOWIDE)	? 5
0151	PERS TON		
	155 A-02 330	CHAL 1-SIMULATICA DE NATEP CHALITY IN STREAMS AND CANALS	. 5
0151	* ACERENT		
	NPO-11314	SAMIS-STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM CCDC 6600 VERSIONS SAMIS-STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM CUMIVAC 2100 VERSIONS FINITE ELEMENT ANALYSIS OF COMPRESSIBLE SOLIDS WITH NOWLINEAR MATERIAL PROPERTIES	91 81
	LAY BEVICE		
	45C-17031	GECHETRY PROCESSOP, HISP TOPULOGY AND NODAL POINT GENERATOR	67
203			
	LAR-13985	ICC-INTERNAL ECCUMENT ITICH GENERATOR	20
	MENTATION		
	R \$2-10450 1 AR-10959	FORTRAN ANALYZER FFCP1-FORTPAN FLOW CHART FFCGRAM FODFR-NIOCK COMMON NON-EPFCLIABLE STATEMENT CENFRATOR DMC-INTERNAL ECCUMENTATION CENERATOR	23 24 26 76
COCU	MENTS		
	C4C-11443	RIBLINGRAPHIC FRICULTS SUBSYSTEM ADMIS-AUTOMATER RATA MARAGEMENT INFERNATION SYSTEM	. 21
0054	S 1		
	IIGA-02340	DOSAG 1-SIMILATION OF WATER QUALITY IN STREAMS AND CANALS	54
0051	GE .		
	EAR-11807	PROTON TISSUE TOSE FOR THE BLOOD FORMING ORGAN IN HUMAN GEONETRY: ISOTROPIC FADIATION	14
0051	METERS		
	144-11802	PROTING TISSUE COSE FOR THE RECOOL FORMING CREAM IN HUMAN GEOMETRY: ISCIRIPTE RADIATION	114
DOUR	LE PRECISI	I CN	
	4PO-11718	MODIFIED UPL SINCLE AND COLDLE PRECISION FORMERS CUAPRATURE SURROUTINES	75
0008	LE PRECISI	CH ARTHMETIC	
	4FS-13127 4FC-14094	DENDRO-SCRUTION OF DIFFERENTIAL FOURTIONS USING THE NORTSTECK METHOD OCLYNOMIAL MATRIX EQUATION SOLVER	71 73
DRAF	TING IDRAW	(14C)	
	GS C-1, 44A	AUTOSKEM 1-ALTCMATEC FLECTRONIC SCHEMATICS	32
DRAG	-		
	4FS-21944	RELV-WATER IMPACT LOACS	41
DR A W	INGS		
	C4-11448	AUTOSKEN 1-AUTOMATIC FLECTPONIC SCHEMATICS PLOTAD-A PACKACE CE FORTRA-I SJBPROGRANS TO DRAW THREE DIMENSIONAL SURFACES	32
DUET	•		
1	MCC-1917A	DUCT-ADJAPATIC COMPRESSIME FLOW OUCH ANALYSIS PROGRAM	53
DUC T	to FLOW		
	P0051-322	THE THE PARTY OF THE FACERAM THAT NUMERICALLY INTEGRATES THE DIFFERENTIAL EQUATIONS THAT DISCRIBE THE THEORY OF A LARGE CLASS OF HEAT PIPES THE HOPENONYMARICS OF A LARGE CLASS OF HEAT PIPES PROGRAM THE PROPERTY OF THE FLOW OUTLY THAT YESTS PROGRAM	47 50
DUC T	s		
		RELECUS CALCLLATION PROGRAM DUCT-ADIAPATIC CEMPRESSIBLE FLOW DUCT ANALYSIS MROGRAM	\$ 1 \$ 0
TY MA	RIC LDADS		
٠,	+SC-17572	LAGEOP-LANCIAC CEAR ECAES PROGRAM	9
DY MA	ALC RESPON	S £	
	148-11109	VASF-VARIABLE CIPENSICA AUTCHATIC SYNTHESIS PROGRAM CENHETALCALLY NORLIMEAR STATIC AND DYNAMIC ARALYSIS OF ARRITRARILY LOADED SHELLS OF REVOLUTION FMA-FRARE POTAL ARALYSIS	9 f

DYN	MIC STRUCT	URAL ANALYSIS	
	D3D-00034	AANDIT-STRICTURAL MATRIX RANGAIDTH REQUIRTION COMPUTER PROGRAM, ODC 6000 SERIES VERSION AANDIT-STRUCTURAL MATRIX RANGAIDTH REQUIRTION COMPUTER PROGRAM, 18M-360 VERSION FORMA-SYNTHESIS OF CYMANIC SYSTEMS USING FORTRAM MATRIX ANALYSIS	71
FAR	TH EPLANETS		
	WF 5-77839	DEVELOPMENT OF FOUR-DIMENSIONAL ATMOSPHEREC MODELS (MORLOWIDE)	5.
F4R'	TH ATMOSPHE	x {	
	196.41-32M	A PROGRAP FOR COPPUTING THE BREGHTNESS TEMPERATURE OF A CLEAR ATMOSPHERE FRUM REDEDSONDE DATA	. 5 !
EARI	TH RESOURCE		
		CONVERT-TECHNIQUE AND COMPUTER PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DENSITY VARIATIONS ASTEP-ALGORITHMIC SIMILATION FEST AND EVALUATION PROCRAM	51
FCAI			
		FCAP-ELECTRONICS CIRCLIT ANALYSIS PROGRAM CCCC VERSIONI FCAP-ELECTRONIC CIRCUIT ANALYSIS PROGRAM ELEM VERSIONI	34
ECN	MMIC ANALY	sts	
	E05-02543	EXILE/EXIST/IRIS-MINEFAL EXPLORATION INVESTMENT OPTIMIZATION AND RESOURCE ESTIMATION COMPUTER PROGRAM	51
FCO	MOMICS		
	MF \$-19740	SPECIAL PACGRAM FOR DISCENSTED CASH FLOW/RATE OF RETURN EVALUATIONS	•:
ECU	· •		
		FCUP-ENGINEFFING CRITICAL CEMPONENTS LISTING	
FD1	TING		
		SCIENTIFIC MACKETIC TAPE LIPRARY SYSTEM	3 7
FOI		ES (COMPUTERS)	
	PAD-00015	GENERAL PURPESE OVERLAY LEAGER FOR CDC 6000 SERIES COMPUTERS CHANGE-FORTRAN IS DIGITAL FROGRAM CHANGE	22
EFF	ICIFACY		
	CDS-02241	SLACHON-SLAC SOFTHARE MONTTON, VERSION 2.2	1
E I G	ENVALUES		
	PFFC1-POH	RELICCHMAS LINEAR ALGERRA LIREARY	6
	LFW-12505	MATER-A CONVERSATIONAL APPROACH TO MATRIX CALCULATIONS-CONCEPTS AND ESTEADING HOLD BRIDGE HEAD FOR STEVENCE THE LINEAR STOCHASTIC OPTIMAL CONTINUES ON A POST ANTIFER LINEAR STOCHASTIC OPTIMAL CONTINUES OF A PROBLEM CONTINUES OF A PROBLEM CONTINUES OF A PROBLEM CONTINUES OF A PROBLE	- 3
		CALCULATION OF FICENVILUES AND FIGENVECTORS OF ARRITMARY MATRICES FORMA-SYMPHETIS OF DYNAMIC SYSTEMS USING FORTRAY MATRIX AVALYSIS	81
		STIRM-FICENVALUE ADUTING BY STURM SEQUENCE METHOD SPIN-FREE VIPRATION ARALYSIS OF SPINNING STRUCTURAL SYSTEMS	71
FIG	DAY ECTOR		
		NEWBRO-AN INFECUED PULTIFLE LINEAR RECPESSION AND DATA ANALYSIS COPPUTER PROGRAM	,
Fts	EWY ECTORS		
•••		RELICOMMOS LIBERA ALGERAR LIBRARY	
	1 FW-10930		8
	LFW-12505	DIGITAL PROGRAM FOR SCENING THE LINEAR STOCHASTIC OPTIMAL CONTROL AND ESTIMATION PROBLEM FIRM VERSIONS	3
	ME 9-02368 MPD-11805	CARCULATION OF FIGENUALUES AND FIGENVECTORS OF ARRITRARY MATRICES STURM-EICENVALUE ROUTING BY STURM SEQUENCE METHOD	7
FE 4	STIC DEFORM	ATTCK	
	[FH-[1744	JET L-ANALYSIS OF JET ENGINE RURSI-ROTCE CONTAINMENT DEVICES	
FLA	STEC PROPER	ntrs	
	466-11411	STRESS-STRUCTURAL THERMAL MAPLO EVALUATION-STRESSES AND STRAINS	6
FLA	STIC SHELLS		
	144-10735	CECHETRICALLY NON-CINEAR ANALYSIS OF APRITRARILY LOADED SHELLS OF PEVOLUTION	
FL 4	50		
	NPO-11555	TEACH-COMPUTER PROGRAM FOR ETHERS EQUILIBRIUM PROBLEMS OF STRUCTURES	1

ELE	CTRIC CONGU	ICTORS		
	LEW-11747	COMPUTER 1250 TECHNIQUE FCP DOCUMENTING COMPLEX WIRING		33
r. e	CTRIC EQUIP	RENT		
	LEW-10299	POWER SUPPLIES USING HIGH FREQUENCY HODULES		11
ELE	CTRIC CEMER	2 ROTAL	:	
	LEW-11749	COMPUTERIZED TECHNIQUE FOR COCCURRETING COMPLEX WIRING		3)
ELE	CTRIC HETWO	DRAS		
	MFS-13094 MFS-15045	ECAP-ELECTRONICS CIRCUIT ARALYSIS PROGRAM (CDC VERSION) ECAP-ELECTRONIC CIRCUIT ARALYSIS PROGRAM (IBM VERSION) MPP-CONTROL SPOSSAM DETERMINES MINIFUM PHASE FROM VARIABLE GAIN CHARACTERISTICS ECAP-ELICTRONIC CIRCUIT ARALYSIS PROGRAM (UNIVAC VERSION)		34 34 34
ELE	CTRIC POLER			
		POSIMO-POWER SYSTEM SIMULATER MONITOR COMPUTERIZED TECHNIQUE FOR DOCUMENTING COMPLEX MIRING		11 33
ELE	CTRIC PROPE	RATIES		
	LEW-10299	TOMER SUPPLIES USING FIGH FREQUENCY MODULES		11
ELE	STRIC WIRE			
	LEW-11749	COMPUTERIZED TECHNIQUE FOR DOCUMENTING COMPLEX WIRING		33
ELE	CTRICITY			
	MSC-14853	SESOP-PROGRAM FOR SOLAR ENERGY HEATING SYSTEMS ANALYSIS		12
ELE	CTROCARDIDG	PHAPA		
		VFTERAMS ADMINISTRATION AUTOMATED ECG AVALYSIS SYSTEM, RELEASE 3.6 CDC 3000 SERIES VERSION VETERAMS ADMINISTRATION AUTOMATED ECG ANALYSIS SYSTEM, RELEASE 3.5 VARIAN 73 VERSION		13
ELE	U09 31#C#13	PREME		
	LEW-11749	SEE-SYSTEMS EFFECTIVENESS EVALUATION COMPUTER VROGRAM COMPUTERIZED TECHNIQUE FOR DOCUMENTING COMPLEX MIRING TOLERANCE ANALYSIS PROGRAM		32 33 35
ELL	IPTIC FUNCT			
	HQN-10735	BARN-BELLCCHP'S APPROXIMATION LIBRARY		67
ENP	LOTEE RELAT			
	MF 5-23073	PFTANN-MSFC ESTIMATED RETIREMENT ANNUITY CALCULATION PROGRAM FORTRAN MARPOSER ACCOUNTING PROGRAM		43
EKE	RGY LEVELS			
	LEW-10/54	FORTRAN BY PECGRAM FOR CALCULATION OF THERMODYNAMIC DATA		92
ERC	INE DESIGN			
		COMPUTER PROGRAM FOR CESIGN POINT PERFORMANCE OF TURROLET AND TURROFAN ENGINE CYCLES COMPUTER PROGRAM FOR PRELIMINARY DESIGN ANALYSIS OF AXIAL FLOW TURBINES		6
E KÇ	THE FAILURE			
		JET 1-ANALYSIS OF JET ENGINE BURST-ROTOR CONTAINMENT DEVICES TAKEOFF AND LANDING PERFORPANCE		8 4 2
ENG	THE HOLSE			
		ATRIBUTED HOLLE STURCE AND CONTOUR ESTEMATION COMPUTER PROGRAM AN IMPROVED PETHOD FOR DESIGN OF EXPANSION CHAMBER MUFFLERS WITH APPLICATION TO AN OPERATIONAL HELICOPTER		7
ENG	INEERING			
		AESOP-A GUICE TO THE AUTCHATED ENGINEERING AND SCIENTIFIC OPTIMIZATION PROGRAM MIDSHIP SECTION DESIGN FOR NAVAL SHIPS		55 79
ENG	INEERING DA	RANINGS		
	000-00053		HICS	71
	GSC-11948	AUTOSKEM 1-ALTOMATIC ELECTRONIC SCHEMATICS		32
ENG	IREERING MA	AMAGERENT		
		POUR PRICERED PROPERTY PARTER A PROPERTY AND A PROP		

ENTIMENT		
	CCMPRESSIBLE LAMINAR OR TURRILENT NONSIMILAR BOUNDARY LAYERS COMPUTER FROGRAM PROCRAM TO DETERMINE RADIATING NONADIARATIC ENVISCED FLOW OVER A BLUNT SODY BY THE METHOD OF INTEGRAL RELATIONS	48
FEM-15500	WASP-A FLERIFLE FORTRAN IV COMPUTER CODE FOR CALCULATING WATER AND STEAM PROPERTIES (IBM VERSION)	93
ENTIRE FUNCTIO	'AS	
HON-10735	RAPA-RELLCCUPY'S APPRICATION LIBRARY	5.7
ENTROPY		
1FW-12206	WASP-A FLEXIBLE FORTRAM IN COMPUTER CODE FOR CALCULATING WATER AND STEAM PROPERTIES (IBM VERSION)	73
FRY IRCZERENT AL	CONTROL	
₩F S-21 082	SIMPLIFIED FLLIC SYSTEM THERMAL ANALYSIS	23
ENVIRONMENTAL	ENGINEERING	
MSC-14853	SESOP-PROGRAP FOR SOLAR ERERGY HEATING SYSTEMS ANALYSIS	12
ENV IROMMENT AL		•
	HANCADOK FCR ESTIMATIAG TCKIC FUEL HAZARDS	52
EQUILIBRIUM EQ		
MUC-10142	FINITE ELEMENT ANALYSIS OF COMPRESSIBLE SOLIDS WITH HOWLINEAR MATERIAL PROPERTIES	70
FOUILIBRIUM FE	CN CN	
MF\$-00443	SCLUTION OF COPPRESSIBLE FLOWS IN PIPING SYSTEMS	47
EQUILIBRIUM ME	THOOS	
₩S-12047	MAPIO SOLLTICE OF LARCE SYSTEMS OF LINEAR EQUATIONS WITH MANDED, SYMMETRIC MATRICES ON THE IBM SYSTEM/38C 64	71
MPD-11555	ELASS-COMPUTER PROGRAM FOR LINEAR EQUILIBRIUM PROBLEMS OF STRUCTURES	
ERROR ANALYSES		
GSC-11499	SIGPAC-SIGNIFICANCE ARITHMETIC EXPERIMENTAL PACKAGE	66
FRRCRS		
**************************************	SCIENTIFIC MACRETIC TAPE LIMARY SYSTEM	37
ERSION		
	ERSION-RELIAPILITY GOAL STATUS	47
	ENSIGNACTIVE CONT. 21103	62
FSATA		
(fw-11693	ESATA-FRECUTIVE SURROUTINES FOR AFTERHEAT TO PERATURE ANALYSIS OF A MOBILE GAS COOLED HUCLEAR PEACTOR FOWER PLANT	12
EST INLT INC		
MF S-23073	RETANN-MSEC ESTIMATED METIMEMENT ANNUITY CALCULATION PROGRAM	43
EVALUAT 104		
MF5-15302 MF5-19043	SAMECS-STRUCTURAL ANALYSIS METHOD FOR EVALUATING COMPLEX STRUCTURES SPECIAL PROGRAM FOR DISCOURTED CASH FLOW/RATE OF RETURN EVALUATIONS	84 40
455-21477	MIS-MAYPOWER MANAGEMENT INFORMATION SYSTEMS	41
MFS-21701 MFS-24103	MARYES - MARSHALL VEHICLE ENGINEERING SIMULATION SYSTEM TEMPO-TECHNICUE FOR EVALUATING MULTIPLE PROBABILITY OCCURRENCES	72
EXC STATION		
EFW-13667 WFS-13094		34 34
EXHAUST SYSTER	ıs en	
	AN IMPROVED PETHED FOR CESSON OF EXPANSION CHAMBER MUFFLERS WITH APPLICATION TO AN OPERATIONAL MELICOPTER	3
	DUCT-ACTAMATIC COMPRESSIBLE FLOW DUCT AWALYSTS PROGRAM	50
EXPANSION		
MF5-1264!	RELEGIS CALCULATION PROGRAM	41
EXPERIMENTAL C	DESIGN OF THE PARTY.	
MFS-14683	COMPRESSIBLE FLOW COMPUTER PROGREM	49
EXPONENTIAL FU	DESIGN CALCULATION PROGRAP COMPRESSIBLE FLOW COMPUTER PROGRAM DESIGN COMPRESSIBLE FLOW COMPUTER PROGRAM DECIDING	
	METHOD FOR NORLINEAR EXPONENTIAL REGRESSION ANALYSIS HP-65 FRILATOR	72

EXTERNAL STORE	is the second of					
LAR-11749 LAR-11753	THEORETICAL PREDICTION OF INTERFERENCE LI	DADING ON AIRCRIFT DADING ON AIRCR FT	STORES-SURSONS STORES-SUPERSO	C CASE		
EXTRAN						
COS-02520	EXTRAN-EXPRESSION TRANSLATOR					Z
EXTRAPOLATION						
HQM-10649 KSC-10419 NPO-11719	PAP-PARAPETRIC ANALYSIS PROCRAM LIPII-LAGRANCE THREE FCINT INTERPOLATION MODIFIED JPL SINGLE AND DOUBLE PRECISION		SUBPOUTINES			67
FATLURE ANALYS	iis					
MFS-19493 MFS-24484 MSC-17446 MIC-13402	INSTRUMENTATION FELIAPILITY ANALYSIS PROS SCORE III-SYSTEM FOR COMPUTING OPERATION. FMEA-FAILURE MODE AND EFFECTS ANALYSIS II TMEAC-THEE ANALYSIS CODE	AL PROBABILITY EQUA	LTIONS			5646
FEEDBACK CIRCU	UITS					
MSC-14094	POLYNOMISE METRES EQUATION SOLVER					7
FFCP1						
KSC-10450	FFCP1-FORTRAN FLOW CHART PROGRAM	1 - 1 - V				2
FIBERS			•			
MP-00041	MIDSHIP SECTION CESION FOR NAVAL SHIPS					7
FILAMENT WINDS	ING.					
NPD-11943	COMTANK-STRUCTURAL DESIGN AND STRESS ANA	LYSIS PROGRAM FOR	ADVANCED COMPOS	STE FELAMENT-400	4)	8
FILE HAIRTENAN	CE (COMPUTERS)					
COS-02480 KSC-10619 KSC-10837		ION SYSTEM				2
FILLETS						
656-15009	MULTIMICK-A COMPLITER PROGRAM THAT NUMERIC THE HYDRODYNAPIGS OF A LARCE CLASS OF HE		HE DIFFERENTIAL	EQUATIONS THAT	DESCRIBE	•
FINANCIAL NAME	AGEMENT					
C95-02540	FXILE/EXIST/IPIS-MINFFAL EXPLORATION INV	ESTHENT OPTIMIZATIO	ON AND RESOURCE	ESTIMATION COMP	ישוני י	5
MFS-19043 MFS-23071 MSC-17556	PROGRAM SPECIAL PROGRAM FOR DISCOUNTED CASH FLOW RETANN-MISC ESTIPATED RETIFEMENT ANNUITY CIM-COST INFORMATION MANAGEMENT COMPUTER	CALCULATION PROGRE	ALUATIONS AM	t e .		• • •
FINITE DIFFERE	NCE THEORY					
64R-13794 64011-843	CEMERAL TRANSIENT HEAT TRANSFER LOMPLITER COMPUTER PPECRAM FOR THE TRANSIENT RESPO OF SMAPE CHANGE	PROGRAM FOR THERM NSE OF ARLATING AX	ALLY THICK WALL ISTMMETRIC 19001	S ES INCLUDING THE	EFFECTS	9
t AR-11663	A COMPUTER PROGRAM FOR CALCULATING INVISION SUPERSONIC AND HYPERSONIC SPEEDS AT ANGLE FORTRAN PROGRAM FOR CALCULATING TRANSPORT	CID, ADIABATIC FLO E DE ATTACK	M ABOUT BLUNT B	DOTES TRAVELING	AT	
EFW-10977	TUREIMACHINE			STREAM SURFACE D	F &	
LEW-11854 MFS-21075 MFS-23177 MSC-19184 NUC-10241	ACMA-AERCTHEFF CHARRING MATERIALS ABLATE RAYFAC-RADIA 11CH VIEW FACTOR PROGRAM PANES-PROGRAM FOR ANALYSIS OF NONLINEAR I PHASE CHANCE SURFOUTHEF FOR USE WITH FIR AUTOTEM-A COMPUTER PROGRAM FOR AUTOMATED	EQUILIBRIUM AND STA	ARILITY POGRAMS	TION CALCULATION	I	9 8 9 9
FINITE ELEMENT	F METHOD					
COS-02 359 000-00033 000-00036 000-00035 000-00053	MASFLAY-FINITE FLEMENT PESH GENERATION P BANDIT-STRUCTURAL MATRIX RANOWIDTH PEDUC RANDIT-STRUCTURAL MATRIX FARMWIDTH PEDUC GRANDIT-STRUCTURAL MATRIX RANOWLITH REDUC GRITZD-1FES-TWO TIPENSTONAL GRID GENERAT FINITE CLEMENT SYSTEMS	TION COMPUTER PROSI TION COMPUTER PROSI TION COMPUTER PROSI OR.AND TERMINAL CO	RAM, IFM-360 VE RAM, UNIVAC ILO NTROL SYSTEM OF	PSION B VERSION THE INTERACTIVE	GRAPHICS	7 7 7 7
DOD-03056 LAR-10053 LAR-11553 MSC-17563 NPO-11319 NPO-11805 NUC-10347	MANDIT-STRUCTURAL MATPIX PAROWIDTH PEDUC SAMIS-STRUCTURAL ANALYSIS AND PATRIX INT SWAP STATICS-STRUCTURAL RETWORK HALLYSIS ALGORITHP FOR MATPIX PANOMICTH REDUCTION SAMIS-STRUCTURAL ANALYSIS ARD MATRIX INT STIRM-FICENNALUR ROUTING RY STURM SEQUEN FINETE FLEMENT ANALYSIS OF COMPRESSIBLE	FPPRETIVE SYSTEM () PROGRAM ERPRETIVE SYSTEM () CE METHOD	CDC 6600 VERSIO	SIONI		7 3 8 7 8 7 9
FITLOS						

FLAME PROPAGIT	10H	
LFW-11740	COMPUTER PROGRAM FOR CALCULATION OF COMPLEX CHEMICAL COURLIGNIUM COMPOSITIONS, ROCKET PERFORMANCE. INCIDENT AND REFLECTED SHOCKS. AND CHAPRAN-JOUGUET DETOMATIONS	L
FLANGES		
MFS-23648	TORSION AMALYSIS OF OPEN SECTIONS	
FLEXIBILITY		
15000-000	PEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM (IRM 7094 VERSION) WEL 21-PIPE FLEXIPILITY ANALYSIS PROGRAM (UNIVAC 1108 VERSION) WEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM (COC 6000 SERIES VERSION) MEL 40-PIPINC FLEXIBILITY ANALYSIS PROGRAM KFLLOGG FIPIPG ANALYSIS FROGRAM	71 71 71 71 84
FLIP-FLOPS		
MFS-2240L	CCMPUTERIZEC LCCIC DESIGN OF DIGITAL CIRCUITS	34
FLOATING POINT		
	CAUSS-MANDEM NUMBER CENEMATER PROGRAM	74
FLOW CHARACTER		•
-		
L AR-11663 LEW-11033 LFW-11677	PCSIMO-PCSER SYSTEM SIMULATER MONITOR A COMPUTER PROGRAM FOR CALCULATING INVISCID, ADIABATIC FLOM ABOUT BLUNT BODIES TRAVELING AT SUPERSONIC ARC MYSTRING SPEEDS AT SINCLE OF ATTACK INVESTIGATION OF ISCTREPPAL COMPRESSIBLE FLOM ACROSS A ROTATING SFALING DAM FORTAMS FOR THE DESIGN OF LIQUID TO LIQUID JET PUMPS COMPRESSIBLE FLOW ACROSS FOR THE DESIGN OF LIQUID TO LIQUID JET PUMPS COMPUTER PROGRAMS FOR PRELIMBERY DESIGN AMALYSIS OF AXIAL FLOW TURBINES	11 39 60
FLOW CHARTS		
GSC-11337 GSC-11332 GSC-11333	FLOMCHARTER- / PROGRAM FOR PRODUCING FLOW CHARTS OF FORTRAM SQUACE DECKS, IRM-358 VERSION SOS 90C CAPIES 1/360 AUTOFICUM PREPROCESSOR SYSTEM TOP 24 STRIES 5/360 AUTOFICUM PREPROCESSOR SYSTEM COC L300C SERIES 5/360 AUTOFICUM PREPROCESSOR SYSTEM UNIVAC L108 1/36C ALTOFICM PREPROCESSOR SYSTEM FFCPI-FORTRAM FLOW CHART PROGRAM	19 22 22 27 22 24
FLOW DISTRIBUT	104	
LAR-11747 LAR-11753 LFW-03234 LFW-13766	THECRETICAL PRECICTION OF INTERFERENCE LOADING ON AIRCRAFT STORES-SUBSCUIC CASE THEORETICAL PRECICTION OF INTERFERENCE LOADING ON AIRCRAFT STORES-SUPERSONIC CASE COMPUTER PROCRAM FOR CALCULATING FLOW DISTRIBUTION. IN A RADIAL-INFLOW TURNING FOR CALCULATING FLOW DISTRIBUTION, IN A RADIAL INFLOW TURNING FOREYARD IN FREGORAN TO ESTIMATE THE OFF DESIGN PERFORMANCE OF RADIAL INFLOW TURNINGS.	9
FLOW VELOCITY		
LFW-10797 LFW-10977 WIC-10376	VELECITIES ARE STREAMLINES ON A BLADE-TO-BLADE STREAM SURFACE OF A TURROMACHINE FORTRAM PROGRAM FOR CALCULATING TRANSCRIC VELOCITIES ON A BLADE TO BLADE STREAM SURFACE OF A TURROMACHINE FOR CALCULATING TRANSCRIC VELOCITIES ON A BLADE TO BLADE STREAM SURFACE OF A TURROMACHINE FOR CALCULATING TRANSCRIC VELOCITIES ON A BLADE TO BLADE STREAM SURFACE OF A TURROMACHINE FOR CALCULATING TRANSCRICTORY OF THE PROGRAM CALCULATING TRANSCRICTORY OF THE PRO	•
	COMPUTER PROCESM CALCULATES PIPING-SYSTEM PARAMETERS	50
FLOW-CHARTER		
	FLOWCHARTER- F PREGRAM FOR PRODUCING FLOW CHARTS OF FORTRAN SOURCE DECKS. IBM-360 VERSION	14
FLUID BOUNDARI		
MSC-17566	SMAC-A NUMERICAL TECHNICUE FOR CALCULATING INCOMPRESSIBLE FLUID FLOWS	50
FLUID FLOR		
LFM-11679 WFS-15149 WFS-21087 WSC-17566 NGC-10189	FERTRAIN ERECEFINE FOR THE CESSEN OF LIQUID TO LIQUID JET PUMPS THERMAL ANALYSIS OF FLUID FLOW IN A PIPE SIMPLIFIED FLUID SYSTEM THERMAL ANALYSIS SMACHA INLERICAL TECHNIQUE FOR CALCULATING INCOMPRESSIBLE FLUID FLOWS TRACK-COMPUTER PROCRAIN FOR TRANSIENT AND STEADY STATE COUPLED FLUID FLOW AND HEAT CONDUCTION	50 93 93 50
	ANALYSIS	
FLUID FLOW ANA		
	SINDA 3G-SYSTEPS IMPROVED HUMERICAL DIFFERENCING ANALYZER FUNIVAC 1100 SERIES VEPSIONS	*4
FLUID HECHANIC		
MF 5-21082	SIPPLIFIED FLUIC SYSTEM THERMAL AMALYSIS	93
FLUIDS		
LFW-11679	GASP-A CEMPUTER CODE FOR CALCULATING THE THERMODYNAMIC AND TRANSPORT PROPERTIES FOR EIGHT FLUIDS-HELBUP-METMANE-AFFRA-HITROTFN-CARRON MONTX-CXYGFM, ARGON, CARRON DIDX 1184-7094 VER)	92
MSC-11933	OPTIMIZATION OF FLUID LINE SIZES WITH PUMPHOR PEWER PENALTY	83
FMA		
#SC-17562	ENT-ENTHE MOLT WHATASES	£3

FME	Α		
	MSC-17446	SMEA-FAILURE MODE AND EFFECTS ANALYSIS INPUT/DUTPUT PROGRAM	4
FOL	5P .		
	NPO-13103	FOLDP-FORTRAN OPTICAL LEAS DESIGN PROGRAM	51
FOR	FCAST.NG		
		COMPUTER UTILIZATION PRECICTION RODEL RELIABILITY BLOCK DIAGRAMS	2
FGR	IER		
	MF 5-18565	FCREER-FCREAR H SURRCUTINE SUBPROGRAM	71
FOR	MA		
	7# S-21490	FORMA-SYNTHESIS OF CYNAMIC SYSTEMS USING FORTRAN MATRIX ANALYSIS	
FOR	MAT		
÷	656-11331 656-11332 656-11333	SOS 900 SERIES 5/340 AUTOFICM PREPRICESSOR SYSTEM DDP 24 SERIES 5/340 AUTOFICM PREPRICESSOR SYSTEM CDC L3000 SERIES 5/360 AUTOFICM PREPRICESSOR SYSTEM UNIVAC 1108 5/360 AUTOFICM PREPRICESSOR SYSTEM SGINDEX-05/360 SYSTEM GENERATION CROSS REFERENCE INDEX	2.2.2.2.2
FOR	TAP		
	656-11398	FORTAP-A GENERALIZED FORTRAN TAPE CONVERSION PROGRAM	2
FOR	TRAM		
	GSC-11399 1FH-10857 MSC-14161	FORTRAN ANALYZER FORTAP-A CENERALIZED SORTRAN TAPE CONVERSION PROGRAM A SET OF FORTRAN IV SURRCLITHES FOR GENERATING PRINTED PLOTS FORTRAN READ PACKAGE CHANGE-FORTRAN IV DIGITAL SPOGRAM CHANGE	2: 2: 2: 2:
FOU	RIER AMALYS	IS Control of the con	
	NPD-11649	FORTER-FORTRAN H SUBROUTINE SUPPROGRAM RETI-ONE DIMENSIONAL REAL FOURIER TRANSFORM OFT-MULTI-OLPERSIONAL COMPLEX FOURIER TRANSFORM	7:
FOU	RIER SERIES		
	MFS-18565	FCRIER-FCRTRAN H SUBHRUTINE SUBPROGRAM	7
FOU	RIFR TRANSF	ORMATION	
		RFT1-ONE OTHERSICNAL REAL FOURTER TRANSFORM CFT-MULTI-OTHERSICNAL CEPPLEX FOURTER TRANSFORM	7
FRA	CTURE MECHA	NICS	
	#SC-13995	FRACTURE MECHANICS EVALUATION OF TI-6AL-4V PRESSURE VESSELS	
FRA	CTURES IMAT	ERTALST	
	MSC-13995	FRACTURE MECHANICS EVALUATION OF TI-6A1-4V PRESSURE VESSES	8
FRA	MES		
	MSC-17562	FMA-FRAME MOCAL AMALYSIS	8
FRA	•		
	#FS-24043	FRAM-PRESSUPIZED STRUCTURE CETTMIZATION	8
FRE	E FLOW		
	LF#-12152	COMPUTER PROGRAM FOR CALCULATING POTENTIAL FLOW IN PROPULSION SYSTEM INLETS	
FRE	E VIERATION		
	MF 5-01 488	TORSIONAL VIERATION NATURAL FREQUENCIES PROGRAM	•
		SPIN-FREE VIERATION ANALYSIS OF SPINNING STRUCTURAL SYSTEMS	7
FRE	OUTHCIES		
	45C-14748	MPP-CONTROL PROGRAM DETERMINES MINIMUM PHASE FROM VARIABLE GAIN CHARACTERISTICS STR-SHELLS OF REVOLUTION APALYSIS PACKAGE LODG GOOD SERIES VERSION) SOR-SHELLS OF REVOLUTION APALYSIS PACKAGE LIDM 360 SERIES VERSION)	8
FRE	QUENCY DIST	RIBUTION	
	MF5-21465	GIPTRAN-GENERAL INPUT PROBABILITY TRANSLATOR PROCRAM FOR STANIARO STATISTICAL DISTRIBUTIONS A COMPUTER PROGRAF FOR STANIANCAL DISTRIBUTIONS	6°

LOSE CESTS		
MSC-179	DO OPTIMIZATION OF FLUID LINE SIZES WITH PUMPING POWER PENALTY	63
FUEL CONSUM	PTION	
L EW-1391	32 COMPUTER PROGRAM FOR DESIGN POINT PERFORMANCE OF TURBOJET AND TURBOFAN ENGINE CYCLES	£
FUEL PURPS		
	79 FORTRAN PROGRAMS FOR THE DESIGN OF LIQUID TO LIQUID JET PUMPS 30 OPTIMIZATION OF FLUID LINE SIZES WITH PUMPING POWER PENALTY	60
FUELS		
WF \$-211	14 HANDBOOK FOR ESTIMATING TOXIC FUEL HAZARDS	- 52
FUNCTIONS C	MATHEMATICS)	
HON-106 KSC-104 LEM-109 LFW-116	18 LIPTI-LAURANCE THREE POINT INTERPOLATION COMPUTER PROGRAM 17 FORTRAN PROGRAP FOR SPLIAE FIT CURVE	55 67 67 68 49
FUSELACES		
LAR-110	13 A OFSIGN SUMPARY OF STALL CHARACTERISTICS OF STRAIGHT WING AIRCRAFT	7
TEYJAFA ZAD		
650-117	TO A COMPUTER PROGRAM FOR QUALITATIVE AND QUANTITATIVE ANALYSIS OF LOW-RESOLUTION MASS SPECTRA	17
GAS COOLED	REACTORS	
ER-116	93 ESATA-EXECUTIVE SUBROUTIMES FOR AFTERMENT TEMPERATURE ANALYSIS OF A MOBILE GAS COOLED NUCLEAR REACTOR FOWER PLANT	12
GAS FLOW		
	15 COMPUTER PROGRAM FOR PRELIPINARY DESIGN ANALYSIS OF AXIAL FLOW TURBINES 86 COMPUTE: PROGRAM FOR QUASI-ONE-DIPCASIONAL COMPRESSIBLE FLOW WITH AREA CHANGE AND FRICTION-APPLICATION TO GAS FILM SEALS	5 49
CAS HIRTURE	s	
650-112	TO A COMPUTER PECGRAM FOR QUALITATIVE AND QUANT. TATIVE ANALYSIS OF LOW-RESOLUTION MASS SPECTRA	17
CAS STREAMS		
L#W-137	43 FORTRAN FREGRAM FOR CALCULATING VELOCITIES AND STREAPLINES ON A BLADE TO BLADE STREAM SURFACE OF A	. 3
	BOUTER BLADE TURECHACHIAE BOUTER STATEMENT AND STREAMLIANCE ON A BLADE-CT-SCALAGE STREAM SURFACE OF A TURBOHACHIME	•
GAS TURBINE	5	
	36 COMPUTER PROCRAM FOR CALCULATING FLOW DISTRIBUTION IN A RADIAL-INFLOW TURBINE 66 FORTRAN IV PETGRAM TO ESTIPATE THE OFF DESIGN PERFORMANCE OF RIDIAL INFLOW TURBINES	3
GASES		
LEW-102	56 FORTRAM IN PECCRAM FOR CALCULATION OF THERMODYNAMIC DATA	• •2
CASP		
LEW-116	29 GASP-A CCMPUTER CODE FOR CALCULATING THE THERMODYNAMIC AND TRANSPORT PPOPERTIES FOR EIGHT FLUIDS-HELTUM-METHAME, NECN-MITROGEN, CARBON MONDX, CXTGEN, ARGON, CARBON DID X LIBM-7094 YER)	92
CAUSS		
MP0-115	28 GAUSS-RANDOM NUMBER GENERATOR PROGRAM	74
GAUSS EQUAT	TON CO.	
650-119	50 NUMENG-MEMERICAL INTECRATION BY GAUSSIAN QUADRATURE	67
CEMS		
GSC-116	41 GEMS-GENERALIZED EVALLATION MODEL SIMULATOR	39
GEOGRAPHIC	ON NUMING-MUMERICAL INTECRATION BY GAUSSIAN QUADRATURE AS GEMS-GENERALIZED EVALUATION MODEL SIMULATOR APPLICATIONS PROCEAN	
MSC-148	23 LARSYS TIT-HILTTSPECTRAL DATA ANALYSIS	57
GEDRACHETIS	n de la companya de Na companya de la co	
GSC-115	97 GEOMAGNETIC FIELT AND FIELD LINE CALCULATION COMPUTER PROGRAM	51
CEOMETRY		-•
	77 ADVANCED STRECTURAL GECHETRY STUDIES	80
LAR-108	72 GENERALIZED CIGITAL CONTOURING PROGRAM 71 ANALYSIS OF CECMPTRY AND DESIGN POINT PERFORMANCE OF AXEAL FLOW TURBINES	25

FUE	r cerra		
	#SC-17930	OPTIMIZATION OF FLUID LINE SIZES WITH PUMPING POWER FEMALEY	. 63
FUE	L COKSUMPT!	CN	
	L EW-13952	COMPUTER PROGRAM FOR DESIGN POINT PERFORMANCE OF TURBOJET AND TURBOFAN ENGINE CICLES	
FUE	L PUMPS		
		FORTRAM PROGRAMS FOR THE DESIGN OF LIQUID TO LIQUID JET FUMPS OPTIMIZATION OF FLUID LINE SIZES WITH PUMPING POWER PENALTY	60
FUE	LS		
	MF 5-21114	MANDBOOK FOR ESTIMATING TOXIC FUEL HAZARDS	52
FUR	CTIONS, EMAT	HERATICS)	
	ARC-10577 1904-10649 KSC-10419 LEM-10917 LFM-11651 MFS-18565	FINDING AN EXTREPUN OF A ECUNDED MULTIVARIABLE FUNCTION MITHOUT DETERMINATION ". E DERIVATIVES PAP-PARAMETRIC ANALYSIS FRECRAM LIFIT-LACRANCE THREE POINT WITERPOLATION COMPUTER PROGRAM FORTHAN PROGRAM FOR SPLINE FIT CURVE FITLING-FORTHAN PROGRAM FOR FITLING LOW-ORDER POLYNCHIAL SPLINES BY THE METHOD OF LEAST SQUARES FORTHER PROGRAM FOR SUBTROGRAM	56 67 67 69 71
FU\$	RAGES		
	LAR-IIOIS	A DESIGN SUPPARY OF STALL CHARACTER ISTICS OF STRAIGHT WING ATRCRAFT	. 7
GAS	MALYSTS		
	GSC-11279	A COMPUTER PPEGRAM FOR QUALITATIVE AND QUANTITATIVE ANALYSIS OF LOW-RESOLUTION MASS SPECTRA	17
CAS	ECOLCO REA	CTORS	
	LEM-11693	CSATA-EXECUTIVE SUBROUTINES FOR AFTERMENT TEMPERATURE ANALYSIS OF A MODILE GAS COOLED NUCLEAR REACTOR FOVER PLANT	12
GAS	FLOW		
	LEW-11815 LFW-12286	COMPUTER PROGRAM FOR PRELIPINARY DESIGN ANALYSIS OF AXIAL FLOW TURBINES COMPUTED PROGRAM FOR DUASI-DIFFICATIONAL COMPRESSIBLE FLOW WITH AREA CHANGE AND FRICTION-APPLICATION TO GAS FILM SEALS	5 49
CAS	MIXTURES		
	GSC-11279	A COMPUTER PECGRAM FOR QUALITATIVE AND QUANT, TATIVE ANALYSIS OF LON-RESOLUTION MASS SPECTRA	17
GAS	STREMS		•
	LEW-10743	FORTRAN FREGRAM FOR CALCULATING VELOCITIES AND STREAMLINES ON A BLADE TO BLADE STREAM SURFACE OF A	. 3
	L EW-10788	TAMOEM BLADE TURECMACHINE VELOCITIES AND STREAMLINES ON A BLADE-TO-BLADE STREAM SURFACE OF A TURBOMACHINE	4
GAS	TURBINES		
	LEW-00236 LEW-10764	COMPUTER PROCRAM FOR CALCULATING FLOW DISTRIBUTION IN A RADIAL-INFLOW TURBINE FORTPAN IN PERCENT TO ESTIMATE THE OFF DESIGN PERFORMANCE OF RADIAL INFLOW TURBINES	3
CAS	ES		
	LEW-10254	FORTRAM TY PECCRAM FOR CALCULATION OF THERMODYNAMIC DATA	92
CAS	P .		
	LEM-11629	GASP-A CCMPUTER CODE FOR CALCULATING THE THERROUTNAMIC AND TRANSPORT PPOPEPTIES FOR EIGHT FLUIDS-HELLUP-PETHANE, NECH, MITROGEN, CARBON MONDX, CXTGEN, BAGON, CARBON DIX 1184-7094 VER)	92
GAU	\$\$		
	NPO-11528	GAUSS-RANDOM NUMBER GENERATOR PROGRAM	74
GAU	NOITAUGS 22		
	GSC-11950	MUMING-NUMERICAL INTECRATICA BY GAUSSIAN QUADRATURE	67
CEX	3		
	GSC-11641	GEMS-GENERALIZED EVALUATION MODEL SIMULATOR	39
GED	GRAPHIC APP	LICATIONS PROCESAN	
	MSC-14823	NUMING-NUMERICAL INTECRATICA BY GAUSSIAN QUADRATURE GEMS-GENERALIZED EVALUATION MODEL SIMULATOR LICATIOMS PROGRAM LARSYS TIT-MULTISPECTRAL DATA ANALYSIS	51
CEO	MAGNETESM		
	GSC-11597	GEOMAGNETIC FIELE AND FIELD LINE CALCULATION COMPUTER PROGRAM	51
CEO	METRY		
		ADVANCED STRUCTURAL GEOPETRY STUDIES	80
		GENERALIZED CIGITAL CONTCUPING PROGRAM ANALYSIS OF CECHTARY AND DESIGN POINT PERFORMANCE OF AXIAL FLOW TURBINES ANALYSIS OF CECHTARY AND DESIGN POINT PERFORMANCE OF AXIAL FLOW TURBINES	25

GLOMORPHOLOGY		
LAR-10872	GEMERALIZED DIGITAL CENTOURING PROGRAM	25
GIBBS FREE EN	ERCY	
LAR-11901	CHEMICAL EQUILIBRIUM OF ABLATION MATERIALS INCLUDING CONDENSED SPECIES	17
GEPTRAH .		
L FW-11462	GIPTRAN-CENERAL INPUT PROBABILITY TPANSLATOR	69
COALS		
	RECORD OF TASK PROGRESS	41
GRAPHS CCHART		
	ALGORITHM FOR RECUCING THE NUMBER OF PEQUIPED POINTS IN A GRAPHICAL DATA SET	21
GRENEX		
650-11512	CREMEX-GODDARC RESEARCH AND ENGINEERING MANAGEMENT EXERCISE SIMULATION SYSTEM	36
CRIDS		
070-02033 000-00035 000-00035 000-20053	BANDIT-STRUCTURAL MATRIX BANDWIDTH REDUCTION COMPUTER PROGRAM, 191-360 VERSION ANNIT-STRUCTURAL MATRIX BANDWIDTH REDUCTION COMPUTER PROGRAM, UNITED 1108 VERSION GRICZD-1FES-TWO EIMENSICHAL GRID GENERATOR AND TERMINAL CONTROL SYSTEM OF THE INTERACTIVE GRAPHICS FINITE ELEMENT SYSTEMS	76 78 78 79
NPD-10127		33
GRIDZO-IFES		.*
070-00053	GPIDZD-1FES-THE CIMENSICNAL GRID GENEPATOR AND TERMINAL CONTPOL SYSTEM OF THE INTERACTIVE GRAPHICS FINITE FLAMENT SYSTEMS	71
GROUND STATES	INS.	
HQN-10305	SEE-SYSTEMS EFFECTEVERESS EVALUATION COMPUTER PROCRAM	32
GROUND SUPPOR	T EQUIPMENT	
KSC-10805	ROEING CEMPLIERIZED PREVENTATIVE MAINTENANCE PROGRAM	39
GUY MIRES		
000-00036	TOWER 12-GUYED TOWER ANALYSIS COMPUTER PROGRAM	79
HARDUARE		
	LOGISTICS HAFCHAPE AND SERVICES CONTROL SYSTEM	39
HAZARDS	Englating transport and gravity doctring start.	
	TRACE-TREE APALYSIS CODE	63
HEART		
	VETERANS ACMINISTRATICN AUTOMATED ECG ANALYSIS SYSTEM, RELEASE 3.6 CCC 3000 SERIES YERSION VETERANS ADMINISTRATICN AUTOMATED ECG ANALYSIS SYSTEM, PELEASE3.5 VARIAN 73 VERSION	13
HEARY DISEASE	S Comment of the second of the	
	VETERANS ADMINISTRATION AUTOMATED ECG ANALYSIS SYSTEM, RELEASE 3.6 CDC 3000 SERIES VERSION VETERANS ADMINISTRATION AUTOMATED ECG ANALYSIS SYSTEM, RELEASE3.5 VARIAN 7º VEPSION	13
HEAT BALANCE		
65C-11159 MSC-19184		91
MEAT FLUX		
MSC-17026	GEMERAL HEAT TRANSFER PREGRAM FOR RAX	94
HEAT PIPES		
GSC-12009	MULTIMICK-A COMPLIER PROGRAM THAT NUMERICALLY INTEGRATES THE DIFFERENTIAL EQUATIONS THAT DESCRIBE	47
. MFS-15149	THE HYDRODYNAMICS OF A LARCE CLASS OF HEAT PIPES THERMAL ANALYSIS OF FLUIC FLOW IN A PIPE	93
HEAT TRANSFER		
	NASPLAY-FIMITE FLEMENT MESH GEMEMATION MACCHAM MINITALE COMMITE PROGRAM THAT MUMERICALLY INTEGRATES THE DIFFERENTIAL FOURTIONS THAT DISTRIBE	71 41
LAR-10794 LAP-11047	THE MYDRODYNAMICS OF A LARGE CLASS OF MEAT PIPES. GENERAL TRANSIENT MEAT TRANSFER COMMITER PROGRAM FOR THERMALLY THICK WALLS.	91
	OF SHAPE CHAPCE CUMPRESSIBLE FLUB COMPUTER PROGRAM	49
MFS-15055	META 11-ROEINC ENGINEFRING THERMAL ANALYZER	9

HEAT TRAN	SFER	
MSC-1	7026 CENERAL SEAT TRANSPORT NUMBERED DIFFERENCING ANALYZER CINEVAC 1100 SERIES FRASIONS	•.
*UC-1	GERZ TAP-A-A PRIGERM FOR COMPLYING TRANSFENT OR STEADY-STATE TEMPERATURE DISTRIBUTIONS	
HEAT TRAN		
2-1.	FORM MULTIMICE-A CEPFUTER ERECPART THAT NUMERICALLY INTEGRATES THE DIFFERINTIAL EQUATIONS THAT DISCRIBE THE HYDRODYNAMICS OF A LARGE CLASS OF HEAT PIPES SETA LI-CEPTACE OF EACH CHORDINAL ANALYZER THERMAL ANALYSIS OF FRUID FLOW IN A PIPE	
REATING	The state of the s	
MSC-1	PIRS PHASE CHANGE SUSPICUTINE FOR USE WITH FINITE DIFFERENCING PROGRAMS	
HEL ICOPTE	S	. •
L44-11	348 AN EMPLOYED PETHOD FOR DESIGN OF EXPANSION CHAMBER MUFFLERS WITH APPLICATION TO AN OPERATIONAL MELICIPATER	
RELIUM		
L E W-11	629 GASP-A CCMPUTER CODE FOR CALCULATING THE THERMODYNAMIC AND TRANSPORT PROPERTIES FOR EIGHT FLUIDS-HELIUM-METHANE, MECH-NITROGEN, CARDON DEN, CANGON, CARBON DIOX EIRM-T094 VERI	
HIGH TERPE	RATURE ENVIRONMENTS	
45C-19	496 RETAFORCED CIFPEN-CERECA MASS LOSS	
MOPS		•
MF S-12	641 BELLOWS CALCULATION PROGRAM	
HUSS		
LEN-13	152 CCMPUTER PRECRAM FOR CALCULATING POTENTIAL FLOW IN PROPULSION SYSTEM INLETS	
YOOS HARUH		
L48-11	BOZ PROTEN TISSUE COSE FOR THE FLOOD FORWING ORGAN IN HUMAN GEORETRY: ISOTROPIC RADIATION	
HUMAN BASTI		
#F5-71	PRO METAROLIC PALINCE ANALYSIS PROGRAM	
	C STABILITY	11
	COMPUTER PROCESUS FOR PRECICING TURBORUMP INDUCER LOADING. STRESS MAGNITUDE. DISTRIBUTION AND VIGERATION CHARACTERISTICS	, (
ит ороот кан 1		
LEW-119 MFS-219	CVA PUTER PROGRAMS FOR PREDICTING TURNOPHING INDUCER LOADING, STRESS MAGNETUDE, DISTRIBUTION CHIPACTER ISTICS 55 KALW-MATER IMPACT LOADS	•
Y GROSTATIC		69
000-000	37 SHCP-SHIP HULL CHARACTERISTICS PROGRAM	
TPERSONIC		7.8
144-110	49 PREGRAM TO CETEPPINE PACIATING MOMENTANCES	
L49-116	PRECRAM TO CETEMPINE PACEATING MOMADIABATIC INVISCID FLOW OVER A BLUNT BODY BY THE METHOD OF THE POTHOD OF A CONCURRENCE OF A PACE OF ATTACK	19
BEAMS		
HF 5-206	AS TORSION ANALYSIS OF CEEN SECTIONS	
DEAL FLUIDS		14
LFW-102*	56 FORTRAN LY PECCHAM FOR CALCULATION OF THIPMODYNAMIC DATA 83 SOLUTION OF COMPRESSIBLE FLOWS IN PIPING SYSTEMS	72
MAGE ENMAN		49
GSC-1201 GSC-1201 NPO-1341		57
MAGE INTENS	SEFTERS	56 57
GSC-1207	AICAB-AIDEC THRUE COMMUNICATION WHO BELBIEARE ZAZZEM AICAB-AIDEC THRUE COMMUNICATION WHO BELBIEARE ZAZZEM	57
AGERY	A CONTRACT OF THE STATE OF THE	57
GSC-1207 4FS-2303 NPD-1341	AICEN-AILEU IMECE CUMMUPICEIIUM EMD BELBIEART 2221EM A AICEN-AILEU IMECE BECIZIERIICH HELMUD WEZEU MECM BINTBA BUMMUTBA WEBZ A AICEN-AILEU IMECE CUMMUPICEIIUM EMD BELBIEART 2221EM A AICEN-AILEU IMECE CUMMUPICEIIUM EMD BELBIEART 2221EM	57 56
	A TO THE TWO IN THE PARTY OF TH	57

MAGES		
	VICAR-VIDED THISE COMMUNICATION AND PETRIEVAL SYSTEM VICAR-VICED THACE COMMUNICATION AND PETRIEVAL SYSTEM	57 57
INAGING TECHNIC	oue \$	
656-17679	VICAR-VIDED IMACE COMMUNICATION AND RETRIEVAL SYSTEM SMIPG-SMALL INTERACTIVE IMACE AROCESSING SYSTEM VICAR-VIDED IMAGE COMMUNICATION AND RETRIEVAL SYSTEM	51 56 51
EMPACT		
[FE-11693	ESATA-EXECUTIVE SUBBOUTINES FOR AFTERHEAT TEMPFRATURE ANALYSIS OF A MOBILE GAS COOLED NUCLEAR REACTOR SCHEFF PLANT	12
IMPACT LOADS		
	KALV-WATER IMPACT LOATS LAGLOP-LANDING GEAR LEATS FROGRAM	47
INCOMPRESS FOLE		
	NUMERICAL SCLUTION OF THE UNSTEADY NAVIER-STOKES EQUATIONS AND APPLICATION TO FLOM IN A RESTANGULAR CANTLY WITH A MOVING BALL COMPUTER PROCESS FOR CALCULATING POTENTIAL FLOW IN PROPULSION SYSTEM INLETS	49
INCOMPRESSIBLE		
15W-11511	EVALUATION OF POTATING INCOMPRESSIBLY LUBRICATED PRESSURIZED THOUST REARINGS SMAC-A NUMERICAL TECHNIQUE FOR CALCULATING INCOMPRESSIBLE FLUID FLOWS	50
INDEPENDENT VA		
H2N-10649 LEW-12439	PAD-PARAMETRIC PARLYSIS FROGRAM FORTRAN IN PROGRAM FOR SYMPTCIC SOLUTION OF UP TO 20 SIMULTANEOUS EQUATIONS FORTER-FORTRAN & SUPROUTINE SJEPROGRAM	6 5 7
THOEXES		
GSC-11612	SGINDEX-CS/36C SYSTEM GENERATION CHOSS REFERENCE INCEX	2 :
INDEXES EDUCUM	ENTATIONS	
MSC-17486 MSC-19423	CONSTAT-A COMPRESENSIVE EMCCHAM FOR TEXTUAL CONCOMPONICES AND STATISTICS INDICES AND CROSS REFERENCES FROM COMPUTER REACABLE TEXT	2
ENERTEA		
4FS-21970	ASTROS-ALTOMATED SHELL THE CAY FOR ROTATING STRUCTURES	8
INFORMATION		
	LARCON-LARCRATORY JOR CENTREL PROGRAM SPENIAL FREGRAM FOR DISCOUNTED CASH FLOW/RATE OF RETURN EVALUATIONS	4
INFORMATION FL	OW	
LAP-11 587	LPC-NASA PERT TIPE 111	. 4
INFORMATION MA	MAGEMENT	
PP 401-PCH	MENSYS-BENLECCEAPHIC SYSTEM RECON/STIMS-REPORTE CONSCIE AND SCIENTIFIC + TECHNICAL INFORMATION MODULAR SYSTEM MENORITY MUSINESS CAPABILITIES FILE	2 4
INFORMATION RE	TRIEVAL	
070-73017 GSC-11957 H24-13426 H24-10699 KSC-10619	ATRICTORAPHIC PRODUTS SLBSYSTEM RCHWET-BELLCOMM INFORMATION PETRIEVAL SYSTEM RCCHVSTIMS-BEWOTE CONSCLE AND SCIENTIFIC + TECHNICAL INFORMATION MODULAR SYSTEM ADMIS-AUTOMATED CATA WARACEMENT INFORMATION SYSTEM FEI-BEHOTE FILE INDUSTRY SYSTEM INDICES AND CHOSS PEFFREECES FROM COMPUTER PEACABLE TEXT	2 2 2 2 2 2 4
INFORMATION ST	rSTEMS	
655-11957	BIBSYS-GIBLICCPAPMIC SYSTEM AIRCIDGRAPHIC PRODUCTS SURSYSTEM BECCY/STIMS-BENDIE CONSCLE AND SCIENTIFIC + TECHNICAL INFORMATION MODULAR SYSTEM	2 2
INFRARED IMAG		
#SC-14823	LARSYS TIT-MEETESPECTPAE DATA ANALYSIS	5
INLET FLOW		
LFW-12152	COMPUTER PROGRAM FOR CALCULATING POTENTIAL FLOW IN PROPULSION SYSTEM IMLETS	

INLET F	PRESSURE		
MFS	00443	SCILUTION OF COMPRESSIBLE FLOWS IN PIPING SYSTEMS	
INPUT			
		PCSIND-PDMER SYSTEM SIMULATOR MONITOP COMPUTER PROCESM TO PEPGE AND/OR MODIFY TABULAR DATA	1 2
IMPUT (DUTPUT F.E	E'IT THES	
MES	S-18725	BLKIO-AN I/O EUFFERING SCHEPE WITH SKIPPING CAPABILITY OSAM-VARIABLE LENCTH INPLT/PUTPUT ROUTINE FORTPAN DEAT PACKAGE	2 2
INPUT/	OUTPUT RE	DUTINES	
MF S	5-24363	COMPUTER PROCESM TO MERCE AMOJOR MODIFY TABULAR DATA	2
INSTRUP	TENT ERRO	OR\$	
MF	5-18489	INSTRUMENTATION PER TAPILITY ANALYSIS PROGRAM	5
INTAKE	SYSTEMS		
		COMMITTER PROCRAMS FOR PREDICTING TURROPUMP INDUCER LOADING. STRESS MAGNITUDE. DISTRIBUTION AND VIRRARITOR CHAPACTERISTICS COMMUNITER PROGRAM FOR CALCULATING POTENTIAL FLOW IN PROPULSION SYSTEM INLETS	
	AL CALSUL		
		MODIFIED JPL SINGLE AND DOUBLE PRECISION ROMBERG CUADRATURE SURROUTINES	7
	AL EQUATI		•
#FS	5-21075	RAVFAC-PLDIATION VIEW FACTOR PROGRAM MODIFIED JPL SINGLE AND COURLE PRECISION ROMREPG QUADRATURE SURROUTINES	9 7
INTEGR	ATED CIRC	CULTS	
LAF	R-11125	ASAP-AM SUTCHATEE STATISTICAL ANALYSIS PROGRAM	3
INTERPO	DLATION -		
KSC	C-10418	PAP-PAPAPETRIC ANALYSIS FRCGRAM LIPII-LACRANCE THREE POINT INTERPOLATION COMPUTER PROGRAM SPLINT-PAPAROLIC SPLINE INTERPOLATION SUBROUTINE	5 6 7
THTERY	ALS		
KSC	C-10419	LIPIE-LACHANCE THREE POINT INTERPOLATION COMPUTER PROCRAM	6
INVENTO	RIES		
esc	-11652	CALICO-CAPITAL ASSETS LOCATION INVENTORY CONTROL	3
INVENTO	-		
		CALICO-CAPITAL ASSETS LOCATION INVENTORY CONTROL LOGISTICS HAPDWAPE AND SERVICES CONTROL SYSTEM	. 3
INVENT	ORY MANAG	GEMENT	
MFS MS(5-24371 C-17122	CALICO-CAPITAL ASSETS LOCATION INVENTORY CONTROL ECHP-ENGINEERING ORITICAL COMPONENTS LISTING PLANT SERVICES RECALL SYSTEM LOGISTICS PECUPLY COMPLIER PROGRAM	3 4 4
INVERSI	i ches		
MSC	-14094	POLYMINIAL MATRIX EQUATION SOLVER	7
INVEST	HENT'S		
MFS	5-19043	SPECIAL PROGRAM FOR DISCOUNTED CASH FLOW/RATE OF FETUPN EVALUATIONS	4
TNYISCI	D FLC		
	1-11663	PROGRAM TO DETERMINE PACIATING NONADIABATIC INVISCIC FLOW OVER A BLUNT RODY BY THE METHOD OF INTEGRAL PELATICAS. A COMPUTER FECOPAM FOR CALCULATING INVISCID. ADIABATIC FLOM AROUT BLUNT BODIES TRAVELING AT SUPERSO. IC AND MYPERSONIC SPEEDS AT ANGLE OF ATTACK.	•
ISUTHER	RMAL FLOW		
t en	(-11033	INVESTIGATION OF ISCTHEPPAL COMPRESSIBLE FLOW ACROSS A ROTATING SEALING DAM	. 5
ISOTHER	ers.		-
		NODAL METMORE THERMAL BALANCE PROGRAM	•
ITERATI	I CN		·
		CONSTRUCT FORTRAN PROGRAM FOR CONSTRUINED FUNCTION MINIMIZATION	6

		THE PROPERTY OF CONSTRAINED SINCTION PINITION	41
	ARC-10896 NPO-10609 NPO-10619	CONNINGE FORTHAN PROGRAM FOR CONSTRAINED FIRCTION PINEMEZATION FOLOP-PORTRAN OPTICAL LERS DYSION PROJECT VERGES DIGITAL COMPUTER SUPROUTINE TO ACCELERATE THE CONVERGENCE OF BREMITEVE PROCESSES	1.
t T	PURPS		40
	118-11674	EDRIRAN PROGRAPS FOR THE CESSON OF LICUID TO LICUID JET CHAPS	
Ŧŧ	1		
	LFW-11389	JET 1-ANALYSIS OF JET FACIAL BURST-ROTON CONTAINMENT DEVICES	•
-	NING		1.
•••		POSEMO-POWER SYSTEM SIMULATOR MINITER	11
	NES CAUNCE		
		RISLEMS CALCULATION POCCEAD	21
	INNAL START		
5 (P.	States terms	EVALUATION OF ROTIFIES INCOMPRISSING LUBRICATED PRESSURIZES THRUST DEARINGS	40
_			
K &		T FILTERING VASP-VARIABLE CIDENSIEM MUTCHATIC SYNTHISIS PROGRAM	M.,
		ATALANTA I I I I I I I I I I I I I I I I I I I	
K A	1 4	and the second parts	44
	m 2-11444	RALV-BATTR TOPACT LCACS	
a f	res	AND AND AND ENTRE	11
	000-00041	MIDSMIP SECTION CESTOR FOR RAPAL SHIPS	
K 1	HET ICS	MULTAN TOR STATES AND PLOW REACTEDAY WITH APPLECATION TO	17
	114-1146	T CENTRAL CHEMICAL REMETICS COMPUTER PROGRAM FOR STATEC AND FLOW REACTEONS WITH APPLECATEON FO COMMUNITION AND SHOCK TURE REMETELS	
ĸI		A DA MERNOREZ	32
	LAR-1117	S ASAP-AN AUTOMATER STATESTECAL ANALYSES PROGRAM	
•	NIC INDEXES		
	M4C-1942	A TANDERS AND CAUSE RELEGENCES FROM CONFORM READARCE TEXT	
ı	PUDAT		. 40
•	414-1814	E CARCON-LABORATORY JOR CERTROL PROJURAN	
ι	ARCHATCRIF!		• • •
	mrs-tate	STATES TO STATES AND CONTROL PRINCIPLE PRINCIP	•
ŧ	ACLUS		•
	#4C-175	TZ EAGENP-LANDING GEAR ENAPS PRICEAN	
· t	ACRANCE MU	The second of th	6.1
	45C-104 Lt M-115	of allfuz-elexisan saccess, sin slip inf tim-libbes bid animiser shelmes by the method of ferzy consult. The finit-ference these boles interdification limbries befores	•
•	NOR REHTER	MARY LAYER	41
	128-109	63. COMBELLES DEL ESMENSE DE EFIERICENT, MONCEMET EN BISINDERA FEATER? COMBUSER BESTIERE	
1	LANIMAR PLO	N	•
	17 9-177	BE COMPUTER PROCESM ITTR CLIASZ-CNT-DIMENSIONAL COMPRESSIBLE FLOW WITH BEER CHARLE AND ERECTION-REPRESSION TO LAS FILM STALS	
	LANCING CE		
	M4C-17*	177 LAGENP-LANDENG CEAR ECATS FRIGRAM	
	-	LIPS.	
	msc - 17	NY LAGEOF-LANDING CERR ECAPS FROMEN	
	-		-
		are territor and fouting territopanis	
	LANGUAGE PE		
		AND FERRAL-FORDFILLING TRANSLATER	
	-	THE COURSE SALE COMPRESSION AND UPDATE PRINCIPLE	

LARGUACES			
MSC-14147	LHEEP-INSTRACTOR OF HOUSTON EASY LENEAR PROGRAMMING SYSTEM		71
LAPLACE TRANSF	PRIACION		
NPO-11649	PELYMONESE MATRIX EQUATION SCRVER RETI-ONE DEMENSICIAL REAL EQUATER TRANSFORM CET-MULTI-DIMENSIONAL COMPLEX FOURIER TRANSFORM		71 74
LARSYS III			
MSC-14871	LARSYS TIT-MULTISPECTOBL CATA ARELYSTS		51
LATERAL STABIL	111		
WF \$-07727	CUTTAN BESTALLE COMMEN		•
LATTICES EMAILS	(MATICS)		
148-11047	VORTER LATTICE PERFAM PROCRAM FOR ESTIMATING SUBSONIC AFRODYNAMIC PLANSORMS	CHARACTERESTECS OF	COMPLER
LAVERS			
-	PICLATZ-A CONFUTER PREGRAM FOR INSTABILITY ANALYSIS OF LAMINATED E	CMG PLATES SUBJECTED	TO COMBINED 91
LATRITS			
MPD- 1382	MIRE CHAIN PECCHAMO UNIVAC 1100 VERSION		31
LEAST SQUARTS	KET HOD		
LEM-11943	RAPIES-FOSTERN IN PROGRAP FOR MULTIPLE LINEAR DECRESSION ANALYSIS AFREDELING	PROVIDING INTERNALLY	EVA_UATED 6
WF 5-771 16	FIRE TISSECTION OF SECOND FOR FITTING INM-PROPER POLYNCHIAL SPLINTS RY NEWERP-AN IMPROVED MILITIPLE LINER RESPESSION AND DATA ANALYSIS COMETHOD FOR MINITORER TERPONENTIAL PECRESSION ANALYSIS THE SFLECTION OF APPROXIMATING FUNCTIONS FOR TABULATED MIMERICAL DESCRIPTION OF APPROXIMATING FUNCTIONS FOR TABULATED MIMERICAL DESCRIPTION AND PROSERVE	MPUTER PROGRAM	SQUARES 6
LENS DESIGN			
	CPDEAM-OPTICAL CERICA AND AMELYSIS FOLDP-ENDITER CPTICAL LIBS CERICAL PROGRAM		51 S
LIBRARIES			
	SCIENTER C MACRETIC TAPE LIPRARY SYSTEM		31
LIFE SUPPORT S	Y51F#S	* * * * * * * * * * * * * * * * * * * *	
MFS-21237	METARTLEC RALANCE ANALYSES PRO RAM		1
LIFT			
144-11047	WORTER LATRICE FORTRAN FOCORAN FOR ESTEMATING SUPSONIC APRODYNAMIC	CHARACTERISTICS OF	COMP.EX
149-11575	MANIFORMS MELTHOPE SUBSCRIC LIFTING SUPFACE METHOD OF AERD CHARACTE	#1STICS	
FIRENC CIRCUIT	\$		
149-11174	STECAP-LINEAR CERCUIT ARALYSIS PROGRAM WITH STIFF SYSTEMS CAPARILE	TY	,
LINEAR POUATIO	es		•
070-0003 070-0004 070-000 0700-000 0700-004 0705-03 0705-03 0705-03 070-005		F-TRO VERSION VAC INCR VERSION VEYWELL VERSION FOURTIONS	7. 7. 2. 6.
450-17468	STATEMENT OF PAIRS PARMICH RETUCTION	innectate natificial by	
LINFAR PROCRAS	at#G		
HSC-14147	THEEP-INITIES OF HOUSTON EASY LENEAR PROGRAMMING SYSTEM		7
LINEAR SYSTEMS		4.5.	
	RELECTMENT LINEAR ALCERRA LIBRARY SYSTEMS LINEATING LISTS A MODESTED NEWTON-RAPHSON RETHOD DIGITAL PROGRAM FOR SIZVING THE LINEAR STOCHAS OPTIMAL CONTROL WRITING	AND ESTIMATION PEOPL	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
LIMITARITY			
49(-13836 MPG-11555	COMMING FORTERS ORIGINAL PERCENCE CONSTRAINED FUNCTION MINIMIZATION FEASA-COMPUTER PRICERS FOR LIMEAR FOCULARMENT MERCHANK OF STRUCTUR	166	•

LINES OF FORCE				
G\$C-11597	GEOPAGNETIC FIELD AND FIELD LINE CALCULATION COMPUTER PROGRAM			51
LIPIL				
KSC-10417	LIPIL-LACRANCE THREE POINT INTERPOLATION COMPUTER PROGRAM	,		67
1.1: CRATURE				
MSC-17484	CONSTAT-A COMPRESSIVE PROCRAM FOR TEXTUAL CONCORDANCES AND STATESTICS			21
LDADS (FORCES)				
000-00074	MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM CIEM 7004 MERSIONS			78
DOD-00026 DOD-00027 DOD-00036 LAM-10477 LAM-104736	MEL 21-PIPE FLERIFICITY ANALYSIS PROCPAM (UNIVAC 110M VERSION) MEL 21-PIPE FLERIPILITY ANALYSIS PROCPAM (CDC 6000 SERIES VERSION) MEL 40-PIPINC (LIXIBILITY ANALYSIS PROCRAM TOMER 12-GUYEC TOMER ANALYSIS COMPUTER PROCRAM STRUCTURAL SYNTHESIS OF A STIFFENED CYLLNOFR GFORCIURAL SYNTHESIS OF A STIFFENED CYLLNOFR GFORCIURAL SYNTHESIS OF A PROLITSIS OF ARRITRAPILY LOADED SHELLS OF PRYOLUTI			2
MFS-15307 MFS-21970 MFS-24047 MSC-14748	GEOMETRICALLY MONINCAR STATIC AND DYNAMIC ANALYSIS OF APRITAARILY LOADED SAMECS-STRUCTURES ANALYSIS HEADD FOR FYALUATING COMPLEK STRUCTURES ASTROS-ALTOMATED SHELL THEORY FOR POTATING STRUCTURES RAX-REMOTE ACCESS TERMINAL CIRCULAR FRAME COMPUTER PROGRAM SOR-SHELLS OF PEVOLUTION ANALYSIS PACKAGE GOOD SCRIFTS VERSIONS	SHELLS OF	KE405011334	\$\$ \$\$ \$\$ \$\$
MSC-14749	SOR-SHELLS OF REMOLUTION ANALYSIS PACKAGE (18M 360 SERIES MERSION)			81
LOGIC		4 1		
CU2-05510	FLOWCHARTER-P FPEGRAM FCP PRODUCING FLOW CHARTS OF FORTRAN SOURCE DECKS, I	BM-340 VER	ST JN	. 19
FORTC DESIGN				
GSC-11333 GSC-11331 GSC-11333 GSC-11333 GSC-11526	FLOWCHARTER-A PROGRAM FOR PRODUCING FLOW CHARTS OF FORTRAN SOURCE DECKS, I SOS 900 SERIES 5/350 AUTOFLOW PREPROCESSOR SYSTEM DOP 24 SERIES 5/350 AUTOFLOW PREPROCESSOR SYSTEM CHO LIBOR 5/350 AUTOFLOW PREPROCESSOR SYSTEM UNITAC 1108 5/350 AUTOFLOW PREPROCESSOR SYSTEM AUTOMIRE 1108 360 VERSICA) COMPUTERIZED LOGIC DESIGN OF DIGITAL CERCUITS	837 C9C-H4	SION	19 22 22 22 31 31
LOGICAL ELEREN	15			
MFS-21701	MARYES - MARSHALL VEHICLE ENGINEERING SIMULATION SYSTEM			- 43
LOSISTICS				
MSC-19116	LOGISTICS RESUPPLY COMPUTER PROGRAM			44
LEGISTICS MANA	CERENT			
	LOGISTICS HARDHARE AND SERVICES CONTROL SYSTEM LOGISTICS RESUPPLY CONGUTER PROGRAM			39
LONGITUDINAL S	TASILLITY			
000-00033	SHCP-SHIP HULL CHARACTERISTICS PROGRAM			71
LUDRICANTS				
	EVALUATION OF POTATING INCOMPRESSIBLY LUBRICATED PRESSURIZED THRUST BEARIN	c s	• •	50
LUGGICATING DI				
LEW-11511	EVALUATION OF POTATING INCOMPRESSIBLY LUBRICATED PRESSURIZED THRUST BEARIN	ES.		50
MACH WINSER				
MF 5-00443	SOLUTION OF COPPRESSIBLE FLOWS IN PIPING SYSTEMS			. 41
MACHINE ORIEST	ED LANCUAGES			
KSC-10837	REL-REMOTE FILE INDUSTRY SYSTEM			. 25
MACHINE OR LENT	ED LANGUAGES ASSEMBLE			
GSC-11438	STRCMACS-05/360 ASSEMBLY LANGUAGE STRUCTURED PROGRAMMING MACROS			21
MACHINE TRANSL	AT LON		•	
COS-02520 GSC-11333 GSC-11331 GSC-11332 GSC-11333	FURTHERN ANALYZER EX! INH-EXPPRISION TRANSLATER SID: 100 STRIES SYNON AUTOFLOW PROPROCESSOR SYSTEM DID 24 SERIES SYNON AUTOFLOW PREPRICESSOR SYSTEM CYC LADGO SERIES SYNON AUTOFLOW PREPRICESSOR SYSTEM LWIVAC LIDR IVYNO AUTOFLOW PREPRICESSOR SYSTEM			2: 2: 2: 2: 2: 2:
GSC-11545 LAR-11695	CAPS-SQUECE DECK COMPRESSION AND UPDATE PROGRAM FOR INTERSECTION A HEW MILTICHARNEL PRACYZER MILTICHARNEL PRACYZER	ILETT-PACKI	IRT MODEL 540	2.2

MACHINE-INDEPE	NOTAT PROGRAMS				100
MSC-14147	UHELP-UNIVERSITY OF HOUSTON EASY LINEAR PROGRAMMING SYSTEM				7
MAGNET IC CORES					
NPD-11494	HTRAC-COMPUTER PROGRAM FOR AVALYSIS OF CIRCUITS INCLUDING MAGNETIC	CORES			3
NACHETIC FIELD	•				
650-11597	GEOMAGNETIC FIELE AND FIELE LINE CALCULATION COMPUTER PROGRAM				5
MACHEY					
LFW-LOTAY	MAGNET-FORTRAN PROGRAM FOR CALCULATING VELOCITIES IN A MAGNEFIED B	EGION ON A CLAI	F TO BLAS	E SURFACE	
	OF A TURNCHACHENE				
MAINTAIRABILIT					
H04-10304	SEE-SYSTEMS EFFECTEVINESS EVALUATION CONTUTER PROGRAM				3.
MATRIFICAL P					
#4C-11137	ROTING COMPLIERIZED PREVENTATIVE MAINTENANCE PROCPAM PLANT SERVICES RECALL SYSTEM				3'
MALFUNCTIONS					
NUC-10402	TRACE-TREE ANALYSIS CODE				: , •
MAN MACHINE ST	STERS	**			
CSC-11517	CREMEX-GODDARD RESEARCH AND ENGINEERING MANAGEMENT EXERCISE SIMULA	TION SYSTEM			3
MAMAGEMENT INF	CRMATION SYSTEPS	•			
GSC-11657 MON-10476 148-11887 MFS-21477 MSC-17177	CALICY-CAPITAL ASSETS LOCATION INVENTORY CONTROL RCWRET-MELLCOPP INFORMATION RETRIEVAL SYSTEM LUC-MASA PERT TIPE III MIS-MANDOWER MEMACEMENT INFORMATION SYSTEMS PLANT SERVICES DECALL SYSTEM				. 3 2 4
MSC-17451 MSC-17556	RECOMM OF TASK PEIGRESS COMMONST INFORMATION MENAGEMENT COMPUTER PROGRAM				
. NPO-13834	MINORITY BUSINESS CAPABILITIES FILE			•	•
NANAGEMENT MET	HCDS				
COS-02390 RSC-10805 MSC-17177 MSC-17451 MSC-17556	CPM-CRITICAL FATH METHCC BREING COMPULERIZED PREVENTATIVE MAINTENANCE PROGRAM PLANT SEPVICES RECALL SYSTEM RECORD OF TAIN PROGRESS CIM-COST INFORMATION MAMAGEMENT COMPUTER PROGRAM				3: 3 4 4
MAMAGERENY PLA	NHING				
COS-02193 GSC-10903 GSC-11641 WFS-21477 WPD-11973	GEMS-GENERALIZED EVALUATION MODEL SIMULATOR MIS-MANPOWER MANACEMENT INFORMATION SYSTEMS				3 3 4
MANAGEMENT SYS	TEMS				
4F5-21669	CEPS-GENERALEZEE EVALUATIC'S MODEL SIMULATOR PMS-JOB RESOURCE OPTIPIZATION MUNITOR FOR PROJECT MANAGEMENT SYSTE A GPSS MODEL FOR JOB RESOURCE ALLOCATION	H PROGRAMS			3
MANGED SPACE F	LIGHT METHOMK				
C2C-10+0+	CANS-COMPUTER ASSISTED RETRORK SCHEDULING SYSTEM				. 3
RANFONER					
MF 5-21 670	MIS-MANPOWER PANAGEMENT INFORMATION SYSTEMS A GPSS MODEL FOR JOR RESCUPCE ALLOCATION FORTRAM MANPOWER ACCOUNTING PROGRAM				•
MAPS					
465-23037	DIGITAL THAGE PEGISTRATION HETHOD BASED UPON BINARY BOUNDARY MAPS				5
MAR SYAS					
ME2-55P15	MARSYAS-MARSHALL SYSTEM FOR ACROSPACE SIMULATION				•
MARVES					
MFS-21701	MARYES - MARSHALL VEHICLE ENGINEERING SIMULATION SYSTEM				•
MASFERY					
- (05-0235)	MASFLAY-FINITE ELEMENT MESH GENERATION PROGRAM				7

MASS		
MFS-21490	FORMA-SYATHESIS OF CYNAMIC SYSTEMS USING FORTHAN MATRIX ANALYSIS	
HASS SPECTRA		
65C-11279 C4911-09F	A CCMPUTER FECREM FOR QUALITATIVE AND QUANTITATIVE ANALYSIS OF LOW-RESOLUTION MASS SPECTRA- THREE SIT MAIS SPECTRAL SEARCH PROGRAM	1
HASS SPECTROSC	CONT	•
NP0-11960	THREE RET MASS SPECIPAL SEARCH PROGRAM	. 1
HASS TRANSFER		•
	ACE-AERCHERM CHEMICAL ECUILIRRIUM COMPUTER PROGRAM REINFORCED CARRON-CARRON MASS LOSS	Į.
RATAR		
Lfw-13833	MATAR-A CONVERSATIONAL APPROACH TO MATRIX CALCULATIONS-CONCEPTS AND IMPLEMENTATION	
MATERIALS HAND		•
# \$C~[9]]6	LOGISTICS RESUPPLY COMPLIER PROGRAM	
HATHEMATICAL M		•
	NCPSS-NADC GENERAL PURPOSE SIMULATION SYSTEM FOR CDC 6300 SERIES COMPUTERS	
H3M-13677	ADVANCED STRUCTURAL GEOMETRY STUDIES	3 i
MF5-21466	RAM-RELIABILITY PARLYSIS MEREL PROGRAM FOR STANEMO STATISTICAL DISTRIBUTIONS	7.
4FS-22672	METHOD FOR HORLIAFAR FREGRESTIAL REGRESSION ANALYSIS MARSYAS-MARSHALL SYSTEM FOR AEROSPACE SIMULATION	77
wf5-22994	A COMPUTER PEDGRAM FOR STANDARD STATISTICAL DISTRIBUTIONS	i
MATRICES		
E48-10877	CEMERAL TIEC CICTIAL CONTOURING PROGRAM	5.
MATRICES EMATH	EMITICSI	
HQM-10738 LAM-10730 LAM-11184 LFW-10439 LFW-11847 TFW-11847 TFS-21440 MFS-21440 MFS-21440 MFS-17560 MSC-17510 MSC-17510	FORTPAIN TY PRECRAM FOR SYMBOLIC SOLUTION OF UP TO 20 SIMILTANTONS FOUNTIONS MATAR-A CONVERSATIONAL APPROACH TO MATRIX CALCULATIONS—CONCEPTS AND IMPLEMENTATION MEMBER-AN IMPROVED MULTIFIE LINEAR RECRISSION AND DATA ANALYSIS COMPUTER PROGRAM CALCULATION OF FIGENVALUES AND FIGENVECTORS OF APPLITABLY MATRICES. MAPIO SOLUTION OF LARGE SYSTEMS OF LINEAR EQUATIONS WITH MANDED, SYMMETAIC MATRICES ON THE IRM SYSTEM/SEO 65	31 31 31 31 31 31 31 31 31 31 31 31 31 3
MATRIE METHODS		•
000+00035	RANDIT-STRUCTURAL MATRIX RANDWIDTH REDUCTION COMPUTER PROGRAM, UNIVAC 1103 VERSION GRIDZO-IFES-TWO CIMENSIONAL GRID CENTRATOR AND TERMINAL CONTROL SYSTEM OF THE INTERACTIVE COMPUTER	71
mo-00056	FINITE ELPPEN SYSTEPS BANCIT-STRUCTURAL MATRIX BANDWIDTH PEDUCTION COMPUTER PROGRAM, HIMSTMETS WEREIDN	. 71
MF 5-07168 MF 5-12947	CALCULATION OF FIGE-WALUES AND ELGENVECTORS OF ARRITMARY MATRICES. RAPIN SPLUTICA OF LARGE SYSTEMS OF LINEAR EQUATIONS WITH MANDED, SYMMETRIC MATRICES DY THE 18M SYSTEM/3ED 69	7
45C-14748 45C-14749	SCR-SHELLS OF FEWELUTION APALYSIS PACKAGE LOCK 6000 SERIFS VERSIONS SCR-SHELLS OF REVOLUTION ANALYSIS PACKAGE LIBM 360 SERIFS VERSIONS	87
#5C-17031 #5C-17963	GECMETRY PROCESSOR, MEST TOPOLOGY AND NODAL POINT GENERATOR ALGORITHM FOR MAININ EANTWICTM REDUCTION	6
45C-17619 HPO-11555	PROGRAM TO RECLEE THE SIZE OF STRUCTURAL MATRICES	81
MPC-13322	MAYEFADAT-STRECTERAL STIFFAESS MATRIX WAVE FRONT RESEQUENCING PROGRAM	91
rat tra		
4PC-10577	FIRDING AN EXTREMUM OF A ROUNDED MULTIVARIABLE FUNCTION WITHOUT DETERMINATION OF THE DERIVATIVES	51
MAXIMUM LIKELI	HOOD ESTEMATES	
f44-11561	SYSTEMS IDENTIFICATION USING A MODIFIED NEWTON-RAPHSON METHOD	59
464M		
KSC-10425	SSCRE-STATESTICAL SUMPARY OF CLIMATOLOGICAL DATA	52
MEASURE AND IN	TEGRATION	•
MF 5-12981	REACH-SUPPLITIES TO SOLVE CIFFERENTIAL EQUATIONS	7 1

HEDIAM ESTA	TSTICS)	
MF\$-011	B MUTLIER TECHNIQUE PROGRAP	70
MEDICAL ELF	PRONICS	
	O VETERANS ADMINISTRATION AUTORATED COG ANALYSIS SYSTEM, RELEASE 3.6 COC 3000 SERIES VERSION IL VETERANS ADMINISTRATION AUTORATED ECG ANALYSIS SYSTEM, RELEASE3.5 VARIAN 73 VERSION	11
HEF SF		
000-000	MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM (IGH 7094 SERSION) MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM (LUNIVAC 1108 SERSION) MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM (COC 6000 SERIES VERSION)	7 6 7 6
F2L 40		
000-000	T MEL 40-PIPING FLEXIBILITY ANALYSIS PROGRAM	71
REMERANE ST	HUCTURES	
C LAR-ILS	9 SHAP DYNAMICS-STRUCTURAL HETWICK AMALYSIS PROGRAM	8.
REMBRANES		
#F\$-192	T STRESS AMALYSIS OF BELLEVILLE SPRINGS PROGRAM	84
REREING RIN	TINES	
NFS-243	COMPUTER PROGRAM TO MERGE AND/OR MODIFY TABULAR DATA	21
RERIDIONAL	/rOA	
1En-110 1En-110	IN COMPUTER PROGRAM FOR CALCULATING FLOW DISTRIBUTION IN A RADIAL-INFLOW TURBINE PANALYSIS OF CEMETRY AND DISIGN POINT PERFORMANCE OF AXIAL FLOW TURBINES USING SPECIFIED MERIDIONAL VELOCITY GRADIENTS	. (
MESH		
	O RASFLAY-FENITE FLEMENT MESH GENERATION PROGRAM ALL AUTOTEM-A COMPUTEM PROGRAM FOR AUTOMATED GEOMETRY MESHING AND HEAT CONDUCTION CALCULATION	95
METACOFIC R	istes	
MFS-212	T METABOLEC RALANCE ANALYSES PROGRAM	Н
METABOLISM		
MFS-212	IT METAROLIC BALFNOF AMALYSIS PROGRAM	1
METAL JOINT		
4FS-126	NE RELLOWS CALCULATION PROGRAM	• 1
RETHARE		
	PE GASP-A COMPUTER CODE FOR CALCULATING THE THE MODINARIE AND TRANSPORT PROPERTIES FOR EIGHT FLUIDS-HELLUP, PETHANE, NEER, NITEGGEN, CARRON MOND, COXYGEN, ARGON, CARBON DIDX EIRM-7094 VER!	9,
MICRODENSIT		
RICROFILES	TO CONVERT-TECHNIQUE AND CEPPUTER PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DENSITY VARIATIONS	51
	50 FFCPI-FCRTRAD FLCW CHART SPCGRAM	20
	FILES ELECTRONIC DEVICE	•
	10 DESIGN OF MICHOSTRIP COMPCAENTS BY COMPUTER	
HICKDHAVE E		
L48-112	10 DESIGN OF MICECSTRIP COMPONENTS BY COMPUTER	3
HICPOHAVE P		
MSC-140	93. A PROGRAM FOR ECHPUTING THE BRECHTHESS TEMPERATURE OF A CLEAN ATMOSPHERE FROM REDIOSONDE DETA	5
MINERALS		
MPO-132	DO NUTPITIONAL ENALLATION OF DIETS	Į,
MININA		
440-105	77 FINDING AN EXIREPUM OF A ROUNDED MULTIVARIABLE FUNCTION WITHOUT DETERMINATION OF THE DEREVATIVES	6
MINISIPATIO		
MF5-164	PRINCE MENERAL PATH AND PEREMAL CUT TECHNIQUES FOR CETERMINING SYSTEM RELIABILITY	4,
HINING		•
C75-029	EXILE/EXIST/IPIS-MIMERAL EXFLORATION INVESTMENT (PINIESIMIES DIA PROCESSIVE ESTIGATION COMPUTER PROCESSIVE PRO	5

	ME2-5147	T MIS-MANPOWER PANAGEMENT INFORMATION SYSTEMS	
	RODAL RESPON	ise and the second seco	
	WC C _ 1.3.0.		
	MSC-1761	FMA-FRANE MOCAL ANALYSES	
	-	PROGRAM TO RECUCE THE SIZE OF STRUCTURAL MATRICES	
	#CODER S		
	MF5-21101	COPPEX-GEDEARE RESEARCH AND ENGINEERING MANAGEMENT EXE CISE SIMULATION SYSTEM 1. MARYS: MARSHALL VEHICLE ENGINEERING SIMULATION SYSTEM 1. COMPUTER UTILIZATION PREDICTION MODEL	
	470-13522	CREATION MASS TRANSIT SEPLEATION MODEL	
	MODES		•
	MFS-21114	MANDEON FOR ESTIPATING TOPIC FUEL IMZARDS	
	MCLECULAR STR	UCTURE	•
	1 24-1004		
	C.L. 10524	FORTRAM IN PREGRAM FOR CALCULATION OF THERMODYNAMIC DATA	
	MOMENTS		•
	#F5-02227	COLUMN ANALYSES COMPLEX	
	HOMATORIC GAS		
	L EW-19256	FORTRAN IN PROGRAM FOR CALCULATION OF THERMODYNAMIC DATA	
	ROHITORS		•
	GSC-11505	STACMON-SLAC SOFTMARE MENITOR: VERSION 2-2 PROGLOME-SLAC PROGRAM PERFERNANCE MENITOR POSINO-PEKER SYSTEM SINCLATER MONITOR POSINO-PEKER SYSTEM SINCLATER MONITOR POSINO-PEKER SYSTEM SINCLATER MONITOR FOR PROJECT PANAGEMENT SYSTEM PROGRAMS	1. 2.
	RONTE CARLO RE	ETHOD	
	148-11125 NUC-10402	ASAP-AN AUTOMATED STATISTICAL AMALYSIS PROGRAM TRACE-TREE ANALYSIS CCDE	
	HTISOR		. 32
		DEVELOPMENT OF FOUR-DIPERSIONAL ATMOSPHERIC POCELS INCREDMIDED	
-	RPP		52
	₩\$-15045	MPP-CONTROL SECORAM DETERMINES MINIMUM PHASE FROM VARIABLE GAIN CHARACTERISTICS	
•	417 8 F	THE TRUE TRUE TAR TABLE GAIN CHARACTERISTICS	34
	HQH-10306	SEE-SYSTEMS EFFECTEVERESS EVALUATION COMPUTER PROGRAM	
,	TRAC	CONTRACTOR CONTRACTOR PROCESSES	32
	NPO-11494	MTRAC-COMPLTER PROGRAM FOR AMALYSIS OF CIRCUITS INCLUDING MAGMETIC CORFS	
•	WFFLFRS	OF CARCOTTS INCLUDING MAGNETIC CORES	15
	LAR-11548	AN IMPROVED PETHOD FOR DESIGN OF EXPANSION CHAMBER MUFFLERS WITH APPLICATION TO AN OPERATIONAL	

41

52

92

RIS

PULTICHANNEL COMMUNICATION

MULTISPECTRAL BAND SCANNERS

MULTIVARIATE STATISTICAL ANALYSIS

PULTIMICK

MACFLLES

128

GSC-12009 MILITIMICK-& CEPPUTER ERCORAW THAT NUMERICALLY INTEGRATES THE DIFFERENTIAL EQUATIONS THAT DESIRED THE HYDROCYNAMICS OF A LARCE CLASS OF MAT PIPES

LAR-11498 PROGRAM FOR INTERFACING A PEWLETT-PACKARD MCDEL 9830 CALCULATOR WITH A MEMLETT-PACKARD MODEL 5401 3 WULTICHANNEL ANALYZER

MSC-14693 ASTEP-AL COR ITEPIC STRULATION TEST AND EVALUATION PROGRAM

MSC-14600 ASTEP-ALCORITHMIC SIMULATION TEST AND EVALUATION PROGRAM MSC-14623 LARSYS III-MILITISPECTPAL OFTA ANALYSIS

LAR-11727 SUBSONIC ANNILAR WING THEORY WITH APPLICATION TO FLOW AROUT NACELLES

ARC-10165 SPEARMAN SHO PULTIPLE RAPK CROER COPRELATION PROCRAM

HAVIER-STOKES	EQUITAND	
: LEW-11415	NUMERICAL SCLUTICS OF THE UNSTEADY NAVIER-STOKES EQUATIONS AND APPLICATION TO FLOW IN A RESTANGULAR CAVITY WITH A PONING BALL	+8
NEON		
LEM-11629	GASP-A COMPUTER CODE FOR CALCULATING THE THERMODYNAMIC AND TRANSPORT PROPERTIES FOR EIGHT FLUIDS-HELIUM-METHANE-NECH-HITROGEN-CARRON MONOX-CXYGEN-ARGON-CARBON DIOX 1184-7394 VERT	42
HETWORK ANALYS	ts	
14R-11184 14R-11529 14R-11530 1EM-10667 1FW-11859 MFS-13094 MFS-18691 MFS-24484 MSC-13805 MSC-17487	ECAP-ELECTRONIC CIPCUIT ANALYSIS PROGRAM (10M YERSION) METWORK PATH FROCRAP	38 33 82 83 34 48 34 40 62 93
RETIDAK SYNTHE		•
GSC-11947 LAR-11125 LEW-10667 MFS-13094	PUZZLE-CEMPUTER AIDED DESIGN OF PRINTED CIRCULT ARTHORK ASAP-AN SUTCPATE STATISTICAL AMAIYSIS PROGRAM ECAP-ELECTROSICS CIRCUIT AMALYSIS PROGRAM ICOC VERSIONS ECAP-ELECTROSICS (IRCUIT AMALYSIS PROGRAM ICOC VERSIONS) ECAP-ELECTROSICS (IRCUIT AMALYSIS PROGRAM ICOP VERSIONS) FCAP-ELECTROSICS (IRCUIT AMALYSIS PROGRAM ICONIVAC VERSIONS)	32 32 34 34
NETWORKS		
	NODAL HETMORK THERMAL BALANCE PROGRAM PUZZLE-COMPUTER AIDEO DESIGN OF PRINTED CERCULT ARTMORK NETWORK PATH ERCCRAP	9: 32 40
NEWRAP		
LEW-11842	NEWRAP-AN INFECVED MULTIPLE LINEAR FECRESSION, AND DATA ANALYSIS COMPUTER PROGRAM	53
RENTCH-RAPHSON	METHOO	
LAR-11261 MFS-23172	SYSTEMS IDENTIFICATION USING A MODIFIED NEWTON-RAPHSON RETHOD PAMES-PROGRAM FOR ANALYSIS OF NOMITHEAP EQUILIBRIUM AND STABILITY	5 9 8 6
NGPSS		
000-00037	NGPSS-NATC GENERAL PLEPCSE SIMULATION SYSTEM FOR CCC 6000 SERIES COMPUTERS	3.8
NIPS		
11000-000	HIPS-HATIONAL MILITARY COMPAND INFORMATION PROCESSING SYSTEM. SYSTEM 363 FORMATTED FILE SYSTEM	21
NOISE INTENSET	Ψ	
ARC-10880	AIRCPAFT NOISE SOUNCE AND CONTOUR ESTIPATION COMPUTER PROGRAM	7
HOISE HEASURER	ENT	
L FW-12285	SCHE PROPULSION SYSTEM ROISE DATA HANDLING CONVENTIONS AND COMPUTER PROGRAMS USED AT THE LEWIS RESEARCH CERTER	•
NOTSE REDUCTED	Market Control of the	
	AIRCRAFT NCISE SCURCE AND CONTOUR ESTIMATION COMPUTER PROGRAM AN IMPROVED METHOD FOR DESIGN OF EXPANSION CHAMPER MUFFLERS MITH APPLICATION TO AN OPERATIONAL HELICOPTER	7 6
NOTSE SPECTRA		
[FW-12285	SOME PROPULSION SYSTEM NOISE DATA HAMPLING CONVENTIONS AND COMPUTER PROGRAMS USED AT THE LEWIS RESEARCH CENTER	9
MONLIMEAR EQUA	TIONS	
418C1-09M	VERGE-A CICITAL COMPUTER SURGUITINE TO ACCELERATE THE CONVERGENCE OF ITERATIVE PROCESSES	. 74
NONLEHEAR SYST	EMS	
L48-11107	AESOP-A CUICE TO THE AUTOMATED ENGINEEPING AND SCIENTIFIC OPTIMIZATION PROGRAM GEOMETPICALLY MONLIMEAR STATIC AND CYNAMIC ANALYSIS OF ARRITRARILY LOADED SHELLS OF REVOLUTION SYSTEMS IDENTIFICATION LSING A MODIFIED MEMON-RAPMSON METHOD	65 61 59
NONLINEARITY		
LAR-10736	COMMIN-A FORTEAN PROGRAM FOR CONSTRAINED FUNCTION MINIMIZATION CFCMFTRICALLY NON-LIMEAR ABALYSIS OF ARBITRAPILY LOADED SMILLS OF REVOLUTION PANES-PROGRAM FOR ANALYSIS OF ROWLINEAP EQUILIBRIUM AND STABILITY	66 83 86

OF PART OF SE

HUNHAL DERSI:Y	FUNCTIONS	
FES-011.5	OUTLIFE TECHNICUE PROGRAM	72
MOZZLE FLOW		
EFU-12176	CALCULATION OF SUPERSONIC STREAM PARAMETERS OF A REAL GAS FROM MEASURABLE QUANTITIES USING FORTHAN IN ROUTINES	49
MOZZLE WALLS.		
4P7-10895	NUMERICAL SCILTICA OF TRANSCHIC FLOW IN A CONVERGENT-DIVERGENT NOZZLE	50
MUCLEAR POWER	PLANTS	
LEH-11693	ESATA-EXECUTIVE SURROUTIRES FOR AFTERHEAT TEMPERATURE ANALYSIS OF A HOBILE GAS SOCIET NUCLEAR REACTOR POWER PLANT	12
MUCLEAR REACTS	ONS	
LAR-11802	PROTON TISSUE COSE FOR THE BLOCD FORMING ORGAN IN HUMAN GEOMETRY: ISOTROPIC RADIATION	- 14
NUMERICAL ARAL	YSLS	
LEW-11743	MUMING-NUMERICAL INTEGRATION BY SAUSSIAN QUADRATURE CCMPUTER PROCRAM FOR CALCULATION OF COMPLEX CHEMICAL EQUILIBRIUM COMPOSITIONS, ROCKET PERFORMANCE, INCIDENT AND PEFFECTED SECRES, AND CHAPPAN-JOUGUET CETONATIONS PROCRAM FOR STANGARD STATISTICAL DISTRIBUTIONS	61 18 72
₩ 5-22994	A COMPUTER PECGRIM FOR STANCARD STATISTICAL DISTRIBUTIONS STARSZS-SHELL THEORY AUTOMATED ROTATIONAL STRUCTURES (STATICS)	72 86
NUMERICAL FLOW	VISUALIZATICA	
MSC-17566	SMAC-A NUMERICAL TECHNICUE FOR CALCULATING INCOMPRESSIBLE FLUID FLOWS	50
NUMERICAL INTE	GRATION	
	NUMING-NUMERICAL INTECPATICA BY SAUSSIAN QUADRATURE	61
HON-13735 LAR-11184 LEW-11467		67 33 17
4FS-00465	CCMMUSTICM APC SPCCK TURE KINETICS AMINT-ADAMS PCLEION INTEGRATION SUNFOUTINE	70
#FS-13122 #FS-15002	DENOPO-SOLUTION OF DIFFERENTIAL EQUATIONS USING THE NORDSIECK METHOD CIRCUS-A DIGITAL COPPUTER FROGRAM FOR TRANSIENT ANALYSIS OF ELECTRONIC SIRCUITS	31
	MARYES - MARCHALL VEHICLE ENGINEERING SIMULATION SYSTEM COMPUTERIZED LOGIC DESIGN OF DIGITAL CIRCUITS	42
45C-19079 4PQ-11713	ADDITION CONVELUTION COPPUTER PROGRAM FOR COST RISK ANALYSIS	73
NURTHG		
GSC-11953	MUMING-NUMERICAL INTEGRATION BY GAUSSIAN QUADRATURE	51
NUTRIENTS		
NPO-13206	MUTPITIONAL EVALUATION OF DIETS	15
NUTRITICA		
NPO-13206	NUTRITIONAL EVALUATION OF CIETS	19
NUTRETIONAL RE	CUIREMENTS	
NPO-13206	HUTRITIONAL EVALUATION OF CIETS	19
OCTAVES		
[FW-12285	SOME PROPULSION SYSTEM NOISE DATA HANDLING CONVENTIONS AND COMPUTER PROGRAMS USED AT THE LEWIS RESEARCH CENTER	•
DDINEX		
LAR-11324	ODINEX-OPTIMAL DESIGN INTECRATION EXECUTIVE PROGRAM	26
ON-LINE PROGRA	MAING	
[FH-13833	MATAR-A CENVERSATIONAL APPROACH TO MATRIX CALCULATIONS-CONCEPTS AND IMPLEMENTATION	6.5
DNE DIMENSIONA		
	CFMA-COMPRESSIPLE FLOW NETWORK ANALYSIS COMPUTER PROGRAM COMPUTER PROGRAM FOR CUASI-CNE-OTMENSIONAL COMPRESSIBLE FLOW WITH AREA CHANGE AND FRICTION-APPLICATION TO GAS FILM SEALS	46
OPDEAN .		
	OPDEAN-OPTICAL DESIGN AND AMILYSIS	59
	EMS (COMPUTERS)	•
	SLACMON-SLAC SOFTWARE MONITOR. VERSION 2.2	19
GSC-1161?	SGIADEX-CS/3ed SYSTEM GENERATION CACS REFERENCE INDEX	23

Orthanian Anna Anna	
MES-16699 FRACT MINIMAL PATH AND PINIPAL CUT TECHNIQUES FOR CETERMINING SYSTEM RELIABILITY NPO-13522 MORGANTOWN MASS TRANSIT SIMULATION MODEL	62 44
OPTICAL CONRECTION PROCEDURE	4.5
GSC-11393 OPDEAM-OPTICAL CESIGN AND ANALYSIS	55
OPTICAL DATA PROCESSING	
GSC-12077 SMIPS-SMALL INTERACTIVE INAGE PROCESSING SYSTEM	56
OPTICAL MEASURING INSTRUMENTS	
LAR-11873 CONVERT-TECHNIQUE AND COMPLIER PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DEMSITY VARIATIONS	56
OPTICAL PROPERTIES	
NPO-10603 FOLCP-FORTRAN OPTICAL LENS CESSON PPOGRAM	57
OPTICAL TRACKING	
FRC-10017 OSRTI-OPTICAL SYSTEMS BAY TRACING GSC-11393 OPDEAN-OPTICAL DESIGN ARC FRALYSIS	55 55
OPTICS	
FRC-10017 OSRTI-OPTICAL SYSTEMS RAY TRACING	. 55
MPT [WAL CONTROL	
ARC-10616 VASP-VARIABLE DIPERSICA JUTCHATIC SYNTHESIS PERGRAM	
OPTIMIZATION	
ARC-10169 AESCP-A GUIDE TO THE MUTCHATED ENGIPEERING AND SCIENTIFIC OPTIMIZATION PROGRAM ARC-10836 CONMIN-A ERRIBAN PROGRAM FOR CONSTRAINED FUNCTION PICKINICS, 25 CF PECCAMP, 26 CF PECCAMP, 27 CF PECCA	65 66 23 38 59 11 40 41 72 43
ORBITAL MECIANICS	
GSC-11499 SIGPAC-SIGNIFICANCE ABITHMETIC EXPERIMENTAL PACKAGE	55
ORDKARCE	
MFS-21955 KALW-WATER IMPACT LEATS	49
ORIFICE FLOW	
MFS-14683 CUMPRESSIBLE FLCE COPPUTER FROGRAM	47
DRT HOCORAL FUNCTIONS	
HON-10738 BELLCOMMAS LIRFAR ALGERFA LIRRARY	\$7
ORT HOGRAPHY ·	
MES-02486 PEINT TRANSFERRATION-CETECORAPHIC TO PERSPECTIVE. FORTRAN H VERSION FOR 360 SYSTEM USE	7 3
ORTHOSTATIC TOLERANCE	
MSC-14386 VECTAN 11-COPFLITED PREGRAM FOR THE MALYSTS OF MECTERCAROLOGRAMS	11
ORTHOTEOPIC CYLINDIAS	
MFS-24043 FRAP-PRESSURIZEC STRUCTURE CREINIZATION	3 (
ORTHOTROPIC SHELLS	
LAP-11569 SALCRS-STRUCTURAL ANALYSIS OF LAYERED CRIMCTEOPIC RING STIFFERED SHELLS OF REVOLUTION. LINEAR STRESS ANALYSIS CRITICA	91
OSATI	
FRC-10017 DERTI-OPTICAL SYSTEMS MAY TRACING	59
OXYCEN CONSUMPTION	
MES-21737 METAROLEC BALANCE ANALYSIS PROGRAM	14
PANELS	

AMES	OF MONITHEAR EQUILIB	VTIJIBATZ CHA MUIJ			
ANES PANES-PROCRAM FOR AN	MEASI2 OF MONEY				. •
AP					67
HON-10649 PAP-PARAMETRIC ANALY	ISIS FREGRAM				* -
PARABOLIC DIFFERENTIAL EQUATIONS		•			74
NPG-13786 SPL'INT-PARABOLIC SPL	LINE INTERPOLATION SUBBLUTTI		•	•	
PARAMETERIZATION					67
HON-10649 PAP-PARAMETRIC ANALY	YSIS PROGRAM				
					40
PATHS MFS-18691 NETWORK PATH PROCRA	n				
					72
PEARSON DISTRIBUTIONS HES-21455 PHOGRAM FOR STANDAR HES-22994 A CCMPUTER PECCRAM	O STATESTICAL DESTRIBUTIONS FOR STANCARD STATESTICAL DE	STRIBUTIONS			72
ME 5-22994 A CEMPOTER 775					40
PERCENTAGE MES-19040 SPECIAL PROGRAM FOR	NISCOUNTED CASH FLOW/RATE	OF RETURN EVALUATIONS			
					65
PERFORMANCE CHARACTERISTICS ARC-10168 LESOP-A GUICE TO TO	SHETDEFRING AND	SCIENTIFIC OPTINIZATIO	N PROGRAM		•,
ARC-10168 LESOP-A GUICE TO T	HE AUTORATED ENGINEERS				
PERFORMANCE PREDICTION			•		62 62
ACCOUNT ACCOUNTS ACCOUNTS ACCOUNT ACCOUNTS ACCOU	FOR COMPUTING OPERATIONAL PR	CBABILITY EQUATIONS K DIAGRAMS			62 75 44
PERIODIC VARIATIONS				•	66
COS-02530 TEDEDA-TIME CEPEN	DENT DATA AMALYZER		•		
PERSONNEL MANAGEMENT				•	40
LAR-11887 LRC-HASA PERT TIP MPD-11973 FORTRAM MANDCHER	F ITE ACCOUNTING PROGRAM				. 44
		COULTIONS			62
MES-24484 SCOPE III-SYSTEM	FOR COMPUTING OPERATIONAL P	*DETRIFILA FORTIONS			
					65
PERIORDATION AFFORMA GUICE TO	THE AUTOMATED ENGINEERING	IND SCIENTIFIC OPTIMIZAT	ION ARTHUM		
		•		•	34
PHASE SHIFT HFS-15045 MPP-CONTROL FFCG	RAN DETERMINES MINIMUM PHAS	E FFOM VARIABLE GAIN CHA	AACTERISTICS		
		and the second s	•		**
MSC-19184 PHASE CHANGE SUF	PROUTENE FOR USE WITH FINITE	Gibbing and and			
PHASES					6.6
COS-02533 TIDEDA-TIME CEP	ENDENT DETA MALYZER				
					94
MES-12622 KELLOGG PIPING	SASLYSTS PRECRAM				93
MFS-12672 COMPRESSIBLE FL MFS-1514R THERMAL ANALYSI	CS CEPPUTER PROGRAM S CF FLUID - LOW IN A PIPE				
•		AL TAMESCEE PREGRAM			71
COS-02410 ISCMETRIC PIPING MES-12672 KELLOGG PIPING	NG SYSTEM CRAWING AND MATERI ANALYSIS PREGRAM	AL TAKE-ELL			
		The nee #2008AM		•	7
C15-02410 15CMETRIC PIF1 010-00024 MFL 21-PIPE FL 000-00025 MFL 21-PIPE FL 000-00025 MFL 21-PIPE FL 000-00027 MFL 40-PIPING	NG SYSTEM EPANING AND MATER EXTRICTLY ANALYSIS PREGRAM EXTRICTLY ANALYSIS PRECEASE FEITH ANALYSIS FRECEASE FEITH FILL ANALYSIS FRECEASE PRESSINE FICHS IN PIPING ANALYSIS FRECEASE FREE FOR ANALYSIS FREE FREE FOR ANALYSIS FREE FREE FREE FREE FREE FREE FREE FRE	COC 6000 SERIES VERSICA SYSTEMS	1 .		7 7 7 4 3
METINGS PIPIPU	S ANALYSIS FREGRAM OF FLUID LINE SIZES WITH PUM FRW CALCULATES PIPING-SYSTEM	DIAC SCHER PISALII	•		,

NUC-10342	FINITE ELEMENT ANALYSIS OF COMPRESSIBLE SOLIOS WITH MONLINEAR MATERIAL PROPERTIES	
PLANFORPS		
L44-11573	MIDIFIED MULTHERF SUBSORIC LIFTING SURFACE METHOD OF AERO CHARACTERISTICS	
	TURAL MERBERS)	
MFS-15302	SAMECS-STRUCTURAL ANALYSIS METHOD FOR EVALUATING COMPLEX STRUCTURES	
PLATFC2FS		
D70-0004L	MIDSHIP SECTION CESIGN FOR MAYAL SHIPS	
PLOTTERS		. '
MFS-15107	ALGORITHM FOR RECUCING THE MUMBER OF REGULTED POINTS IN A GRAPHICAL DATA SET	
PLOTTING		2
470-10127	PLOT30-A PACKACE OF FORTRAN SUPPORGRAPS TO DRAW THREE DIRENSIONAL SURFACES A SET OF FRATRAN BY SUBPOUTTNES FOR GENERATING PRINTED PLOTS OUTLIER TECHNICUE PROGRAP ALGORITHM FOR RETUCING THE NUMBER OF REQUIPED POINTS IN A GRAPHICAL DATA SET VIRRATIONAL TRANSER FUNCTIONS FOR PASE EXCITED SYSTEMS CAPA-COMPRESSION ALGORABLE PLOTTING ROUTINE FORTRAN BY SUPPOUT MES ERFO CONTOUR IN CONTINE	3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4
	MTRAC-COMPLIER PROGRAP FOR EMELYSIS OF CIRCUITS INCLUDING MAGNETIC CORES	1
PLOT30		
	PLOT30-A PACKAGE OF FORTRAN SUBPROGRAMS TO DRAW THREE DIMENSIONAL SURFACES	. 4
PRS		
	PMS-JOS RESCUPCE CPTIMIZATION MONITO' FOR PROJECT MANAGEMENT SYSTEM PROGRAMS	4
POINTS INATHER	HATTES)	
MFS-02485	FORTRAN PROGRAM FOR SPLINE FIT CURVE POINT TRANSFORMATION-ORTHOGRAPHIC TO PEPSPECTIVE, FORTRAN H VFRSION FOR 360 SYSTEM USE ALGORITHM FOR PECUCING THE NUMBER OF PROVIERED POINTS IN A GRAPHICAL DATA SET	6 7 2
POISSON EQUATI		٠
LEW-11415	NUMERICAL SCILLICA OF THE UNSTEADY NAVIER-STOKES EQUATIONS AND APPLICATION TO FLOW IN A RESTANGULAR CAVITY WITH A MOVING BALL	•
POISSON RATIO		
#SC-12706	CAPR-COMPRESSION ALLOHABLE PLOTTING ROUTINE	8
POLLUTION		
MFS-21114	HAMDROOK FOR ESTIMATING TORIC FUEL MAZAROS	. 5
POLYHEDROHS		,
M04-10677	ADVANCED STRICTURAL GECHETRY STUDIES	
POLYNOHIALS		8
LFM-10917 LFM-11651 MSC-14094	FORTRAM PROGRAM FOR SPLINE FIT CUPVE FITLOS-FCRIBAM PROGRAM FOR FITTING LOM-DROER POLYNOMIAL SPLINES BY THE METHOD OF LEAST SOJARES POLYNOMIAL MATPIX EQUATION SOLVER	6 7
POPULATION		·
NF0-11528	GALES-PANDED PLUEER CENEPATER PROGRAM	7
POS INO		·
GSC-11505	PCSIMO-PCHEM SYSTEM SIMULATOR MONITOR	1
POZER		•
GSC-11159	MCDAL NETWORK THEPMAL RALANCE PROGRAM	
POWER SPECTRA		. 3
NPG-11649 NPG-11651	RFTI-ONE DIMENSIONAL MEAL FOURIER TRANSFORM CFT-MULTI-DIMENSIONAL COMPLEX FOURIER TRANSFORM	7
REDICTIONS		•
#F5-226AA	COMPUTER UTILIZATION PREDICTION MODEL	21
PRESSURE		•
LEM-11691	ESAYA-FRECUITISE CURROLTINES FOR AFTERHEAT TEMPERATURE ANALYSIS OF A MORILE GAS COOLED NUCLEAR	•
	REATTOR PUMES PLANT FRAP-PRESSURIZED STRUCTURE CREMIZATION	12

MSC-17566	SMAC-A HUMERICAL TECHNICLE FOR CALCULATING INCOMPRESSIBLE FLUID FLOWS	50
PRESSURE DISTRI		
LAR-11197	COMPUTER PROGRAM TO DETERMINE PRESSURE DISTRIBUTION AND FORCES ON ECUNT BODIES OF REVOLUTION	
PRESSURE DACP		
LEW-12113	CFM4-COMPPESSIBLE FLOW AFTECRE ANALYSIS COMPUTER PROCRAM RECEMBRATIVE COOLING CESICA/ANALYSIS COMPUTER PROCRAM COMPRESSIBLE FLOW COMPUTER PROCRAM COMPUTER PROGRAM CALCULATES PIPING-SYSTEM PARAMETERS	48 93 47 50
PRESSURE VESSE		
	FRACTURE MECHANICS EVALUATION OF TI-6AL-4V PRESSURE VESSELS	57
PRESSURE VESSE		
	FRACTURE MECHANICS EVALUATION OF TI-6A1-4V PRESSURE VESSELS COMTANX-STRUCTURAL CESICN AND STRESS ANALYSIS PROGRAM FOR ADVANCED COMPOSITE FILAMENT-WOUND AXISYMMETRIC PRESSURE VESSELS	87 89
PRETREATHENT		
	BOEING COMPUTERIZED PREVENTATIVE MAINTENANCE PROGRAM	39
PREVENTION		
	BOEING COMPUTERSIED PREVENTATIVE MAINTENANCE PROGRAM	39
FRINTEU CIRCUI		
· · ·	PUZZLE-CCMPUTER SIDEO DESIGN OF PRINTED CIRCUIT ARTHOPA	32
HPO-11 382	WIRE CHAIN PROGRAM, UNIVAC 1:08 VERSION	. 35
PRINTERS EDATA	PRCCESSING	
LEW-10857	A SET OF FORTRAN IN SUBBOUITHES FOR GENERATING PRINTED PLOTS	27
PROBABILISTIC	CALCULATIONS	
LEW-11462	GIPTRAN-CENEPAL INPUT PROBABILITY TRANSLATOR	67
PROBABILITY DE	NSITY FUNCTIONS	
MSC-17487 MSC-19078	TOLFRANCE AMPLYSIS PROGRAM ACCITION CONTROL PROGRAM FOR COST RISK AMALYSIS	35 73
PROBABILITY TH		
MFS-24103 NPD-13304	TEMPO-TECHNIQUE FOR EVALUATING MULTIPLE PROBABILITY OCCUPRENCES RFLIABILITY COMPUTATION FROM RELIABILITY BLOCK DIAGRAMS	12 15
PROCEDURES		
MFS-22997	A COMPUTERIZED SOLUTION OF THE KEPNEP-TRESOE METHOD ALGORITHM	43
PROCUREMENT MA	NAGEPENT	
GSC-11552	CALICO-CAPITAL ASSETS LOCATION INVENTORY CONTPOL	39
PRODUCTION ENG	TINEERING	
KSF-10895	BREING COMPUTERIZED PREVENTATIVE MAINTENANCE PROGRAM	31
PROGLODK		
C95-02251	PROGEDOM-SEAC PROGRAM PERFORMANCE MENTER	20
PROGRAMMING		
LAR-10987 LAR-11414	DCC-INTERNAL COCUMENTATION GENERATOR BURIO-AN I/O SUFFERING SCHEME WITH SKIPPING CAPABILITY	26 21
PROGRAMMING E	SCHEDULING!	
COS-02390	CPW-CRITICAL FATH METHOC	31
PROCRESS		
MSC-17451	PECCPD OF TASK PROGRES.	• •3
PROJECT HANAS	EMENT	
MFS-21669	CFM-CRITICAL FATH METHOD PMS-JOB PESCLOCE OPTIMIZATION MONITOR FOR PROJECT MANAGEMENT SYSTEM PROGRAMS RECOPD OF TASK PROGRESS	31 41 43
PROJECT PLANN	I NG	
t AR-11887 MSC-19079	ERC-MASA PERT TIME III ADDITION CONVCLUTION COMPUTER PROGRAM FOR COST PISK AMALYSIS	73

THUS CLIS		-
- 5 5-21 669	PMS-JOB RESCURCE OPTIMIZATION MONITOR FOR PROJECT MANAGEMENT SYSTEM PROSPARS	41
PRU ULSTON		
LEW-12785	SINE PROPRIESTER TYSTER REISE DATA HANDLING CONVENTIONS AND COMPUTER PROSPAMS USED AT THE LEMIS PESSARCH CENTER	•
PROPULSION SYS	TEM PERFORMANCE	
LEW-10452	COMPUTER PROGRAM FOR DESIGN POINT PERFORMANCE OF TURROJET AND TURBOFAN ENGINE SYCLES	
PROTEIRS		
NPD-13206	NUTRITIONAL ENALLATION OF CIETS	15
PUNCHED CARDS		
MF\$-24360	COMPUTER PROGRAM TO MERCE AND/CR MODIFY TAGULAR CATA	24
PULZLE		
CSC-11947	PUZZLE-COMPUTER ATOED DESIGN OF PRINTED CINCUIT ARTHURK	32
-		
tan-11750	THEORETICAL PREDICTION OF INTERFERENCE LOADING ON ATROPAST STORES-SUPERSONIC CASE	•
PTROLTTIC NATE	RTALS	
LAR-11801	CHEMICAL EQUILIBRIUM CF ARLATION MATERIALS INCLUDING CONDENSED SPECIES	11
QSAM		
MFS-18725	OSAP-VARIABLE LENGTH IMPLA/OUTP.IT ROUTINE	28
CUADRATURES		
NP0-11718	MODIFIED JPL SINGLE AND COURLE PRECISION ROMBERG QUADPATHRE SURPOUTINES	75
QUAL 1		
UG4-02170	QUAL 1-SIMULATION OF NATER QUALITY IN STREAMS AND CANALS	53
QUALITATIVE AN	IALYSIS	
656-11279	A COMPUTER PROGRAM FOR GUALITATIVE AND QUANTITATIVE ARREVSIS OF LOW-RESOLUTION MASS SPECTRA	17
QUARTITATIVE A	HALYSIS	
655-11279	A COMPUTER PROGRAM FOR QUALITATIVE AND QUANTITATIVE ANALYSIS OF LOW-PESOLUTION MASS SPECIAL	17
RADIAL DISTRIC	NOTION	
LF#-10471	ANALYSIS OF CECHETRY AND DESIGN POINT PERFORMANCE OF AXIAL FLOW TURBINES	,
RADIAL FLOW		
	COMPUTER PROCESS FOR CALCULATING FLOW DISTRIBUTION IN A RADIAL-INFLOW TURBINE FORTERN FRICE OF CALCULATING VELOCITIES AND STREAMLINES ON A BLADE TO BLADE STREAM SURFACE OF A	3
	TANDEM BLACE TURECHACHIAN. FORTRAIN TO PETITIPATE THE CFF DESIGN PERFORMANCE OF RADIAL INFLOW TURBINES COMPUTER PROCRAMS FOR AZIAL FLOW COMPRESSOR DESIGN	3
RADIATION		
LAR-11802	PROTON TISSUE DOSE FOR THE MOOD FORNING DRAM IN HUMAN GEDNETRY: ISOTADIC RADIATION	14
RABIATION DOSA	GE ,	
LAR-11802	PROTON TISSUE COSE FOR THE BLOOD FORMING DREAM IN HUMAN GEOMETRY: ISUTROPIC RADIATION	14
RADIATION EFFE	ECTS	
MFS-15002	CIRCUS-A DIGITAL COMPUTER PROGRAM FOR TRANSIENT ANALYSIS OF ELECTRONIC CIRCUITS	34
RADIATIVE HEAT	TRANSFER	
#SC-17026	GENSRAL HEAT TRANSFER PROCESM FOR RAX	14
RADITOSONOES		
MSC-14093	A PROGRAM FCP CCMMUTING THE BRICHTHESS TEMPERATURE OF A CLEAR ATMOSPHERE FROM RADIOSONDE DATA	53
RAM		
HES-14513	RAM-RELIABILITY ANALYSIS MCDEL	61
-	Samuel Control of the	
	RARN-RELICOMP'S APPROXIMATION LIBRARY GAUSS-RANDEM NUMBER GENERATER FROGRAM	67

RANCE EEXTRE	MPSS	
44C-1051	FINDING AN EXIPERUM OF A REUNDED PULTIVARIABLE FUNCTION WITHOUT DETERMINATION OF THE DERIVATIVES	٠.
RAKKING		
	SS SPEARMAN RHO PULTIPLE RANK ORDER COPRESATION PROGRAM DD TEMPO-TECHNICUE FOR EVALUATING MULTIPLE PROBABILITY OCCURRENCES	6.7
FITTAR		
t Fw-1106	77 RAPIER-FERTREN IN PROGRAM FOR MULTIPLE LIMEAR REGRESSION ANALYSIS PROVIDING INTERNALLY EVALUATED REMODELING	
RAREFACTEDN		
#50-1945	STANTON NUMBER-REFOCENANTE HEATING	1
RAVFAC		
₩ 5-21 D7	S RAVEAC-RECEATION VIEW FACTOR PROCESH	
RAX		
MF 5-2404	2 RAK-REMOTE ACCESS TERPINAL CIRCULAR FRAME COMPUTER PROSPAN	8:
RAY TRACING		
F#C-1001	7 OSRTI-CPTICAL SYSTEPS BRY TRACING 3 OPPERM-OPTICAL DESIGN AND ANALYSIS	59
RAYLEIGH DIS	TRIBUTION	
NPO-1157	M GAUSS-RANDOM ALMREN GENERATER PROGRAM	7
RC CIRCUITS		•
#F\$-1505	S ARTA II-BORING ENGINEERING THERMAL AMALTZER	•:
REACTOR MATE		•
	TRACK-COMPLTER PROGRAM FOR TRANSIENT AND STEACY STATE COULTED FLUID FLOW AND HEAT CONDUCTION ANALYSIS	• •
READERS		
#SC-1416	1 FORTRAN PEAC FACKAGE	29
FAL CASES		-
LFW-1232	6 CALCULATION OF SUPERSIMIC STREAM PARAMETERS OF A PEAL CAS FROM MEASURABLE QUANTITIES USING FORTPAY IN ROUTINES	49
REAL MURSERS		
656-1139	B FORTAP-A GENERALIZED FERTRAN TAPE CONVERSION PROCESM	22
RECORDS		
# \$C - 1061	9 ADMIS-AUTCMATED DATA PARACIPENT INFORMATION SYSTEM 9 COMPUTER UTILITATION PRECICIION MODEL	25
RECTANGLES		
1 FW-134F	PERTONA PACKACE IN FRETHAN SUBPROGRAMS TO PRAW THREE DIMENSIONAL SURFACES	21
ECTANGULAR	MERGS	
144-1101	3 A DESTON SUMMARY OF STALL CHARACTERISTICS OF STRAIGHT WING AIRCRAFT	,
RECURSIVE FU		•
4FS-2213	5 THE SELECTION OF APPROXIMATING FUNCTIONS FOR TABLIATED IN MERICAL DATA	72
LEFERFRCE SY		•••
G <c-1195< td=""><td></td><td>23 23</td></c-1195<>		23 23
#5C-[942	3 INDICES AND CODES REFERENCES FROM COMPUTER REACABLE TEXT 3 INDICES AND CODES REFERENCES FROM COMPUTER REACABLE TEXT	21
FELECTANCE		
	7 OSRTI-OPTICAL SYSTEMS PAY TRACENS	55
EGENETATIVE		
	3 RECENERATIVE COOLING CESTON/ANALYSIS COMPUTER RPOGRAM	73
LEGRESSION A		
	P RAPTER-FORTRAN IN PROCRAM FOR MULTIPLE LINEAR RECRESSION ANALYSIS PROVIDING INTERNALLY EVALUATED REMODELING	44
1 fw-11 p4	7 NEWBER-AN IMPROVED RULLIPLE LINEAR PROPESSION AND DATA ANALYSIS COMPUTER PROCRAM	69

REDUCTATION COL	FFICIENTS	
	BAPTER-PORTPAN IN PROCRAM FOR MULTIPLE LINEAR REGRESSION ANALYSIS PROVIDED INTERNALLY EVALUATED REMODELING WITHOUT MULTIPLE LINEAR REGRESSION AND DATA ANALYSIS COMPUTER PROGRAM.	61
REESFORCEMENT		
	SALDES-STRUCTURAL ANALYSIS OF LAYERED DATHOTEOPIC ALIG STIFFEMED SHELLS OF REVOLUTION, LIMEAR STRESS ANALYSIS CPTICA	1)
	STARSPS-SHELL THEORY AUTOMATED ROTATECHAL STRUCTURES ESTATICS!	**
REISSMER THEO		
MFS-21027	STARSES-SHELL THEORY AUTOMATED ROTATIONAL STRUCTURES (STATICS)	
RELIABILITY		
₩F \$-744#4 ₩PD-17 906	FRACT MINIMAL PATH AND PINIMAL CUT TECHNIQUES FOR DETERMINING SYSTEM RELIABILITY SCORE ILI-SYSTEM FOR COMMUTING OPERATIONAL PROBABILITY EQUATIONS RELIABILITY PLOCK CIAGRAMS TRILIABILITY COMPITATION FORM RELIABILITY PLOCK CIAGRAMS TRACE-TRRE ANALYSIS CODE	52 62 75 63
RELIABILITY G	IALYSIS	
MFS-74171 MFS-74480 MSC-17446	EFACT MINIMAL PATH AND PIRIMAL CUT TECHNIQUES FOR DETERMINING SYSTEM RELIABILITY APPORTSCHAPP	62 52 62 52 53
RELIABILITY F:	ICINEFALIS	•
	INSTRUMENTATION RELIABILITY ANALYSIS PROGRAM APROCI-APPCRITCHENTARECICTION	56 67
REMOTE SENSORS		
47051-372 47051-372 47811-881	VICAR-VICED SPACE COMMUNICATION AND RETRIEVAL SYSTEM SHEPS-SHALL SATERACTIVE SHACE PROCESSING SYSTEM CONVERT-TECHNIQUE AND COPPLITE PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DENSITY VARIATIONS OLGITAL SHACE RECISTRATICA METHOD RAFFD UPON RIMARY POUNDARY MAPS (ARSYS TIT-MLXITSPECTRAL DATA ANALYSIS	51 46 56 57
REPORT CENERAL	IDAS	
76-0224 76-277 7600-000 7601-404 7701-328 77801-32 77801-82 77801-83	MIS-MANPOWER PANACEMENT INFORMATION SYSTEMS FOUR-ENGINEFRING CRITICAL COMPONENTS LESTING FORTRAN PEAC ECCARGE	37 10 77 21 24 25 25 27 61 43 29
REPERTS		
#4C-1981a	MULTIPLE UTILITY COMPLTER PROGNAM LOGISTICS HARDWAFE AND SERVICES CONTROL SYSTEM	39
RESEARCH AND I	DE A&F COLUEN A	
646-11413	CARRET-GODPARD RESEARCH AND ENGINEERING NAMAGENENT EXERCISE SEMILATION SYSTEM	38
RESEARCH HARAC	CAC MA.	
650-11917	CREMEN-GOODARD MESTARCH AND ENGINEERING MANAGEMENT ENERCISE SEMMATION SYSTEM	30
BE SERVES		
COS-02543	ENTIFYERST/TPIS-MINERAL EXPLORATION INVESTMENT OPTIMIZATION AND RESOURCE ESTIMATION COMPLEX PROGRAM	51
RESTUUAL STREE	(5	
WF \$-74042	RAB-REMOTE ACCESS TERMINAL CIRCULAR FRAME COMPUTER PROGRAM	- 65
RESCRIPT FREQU	recus.	
MFS-01488	COMPUTER PROCESH FOR CALCULATING CRITICAL SPEEDS OF ROTATING SHEETS TORSIONAL VIPRATION NATURAL FREQUENCIES PROGRAM FRA-FRANE MCCPL ENALYSIS	60 61
RESCHAPE VIBLE	FICH	
MF 5-01 488	TORSEDNAL VIERATION NOTURAL FREQUENCIES PROGRAM	

		3.8
Mer - 3044B	CANS-COMPUTER ASSISTED RETAINER SCHEDULING SYSTEM PRS-JOB RESOURCE OPTIMIZATION HONETOR FOR PROJECT MANAGEMENT SYSTEM PROGRAMS A GRSS MCDEL FER JOB RESCURCE ALLOCATION	41
RESOURCES		33
GSC-11652 MFS-21477	CALICO-CIPITAL ASSETS LOCATION INVENTORY CONTROL GIS-MANPOWER PANAGEMENT INFORMATION SYSTEMS	41
RETARM		43
MFS-23073	RETANN-MIFC ESTIMATED RETIFEMENT ANALITY CALCULATION PROGRAM	
PETIREMENT		43
MFS-23073	RETAIN-MISEC ESTIPATED PETIFERENT ANNUITY CALCULATION PROGRAM	. **
REVISIONS		20
COS-02513	FORTRAM ANALYZER	•
REACTALIE	ARIPER CURLLE DE BEACH IT 17W	81
L4R-11109	GEOMETRICALLY MONLIMEAR STATIC AND DYNAMIC ANALYSIS OF AFBITRARILY LOADED SHELLS OF REPOLITION	
REYNOLDS NUME		
45 C-19493	STANTON NUMBER-AERODYNAMIC HEATING	
RFI		- 25
KSC-10837	REI-RENOTE FILE INQUIPY SYSTEM	.,
RFT1		74
NPO-11649	RETI-ONE DIMENSIONAL REAL FOURIER TRANSFORM	. • •
RICCATI EQUATI		31
ARC-17616	VASP-VARIABLE DIMENSION AUTOMATIC SYNTHESIS PROGRAM	·•
RING STRUCTURE	es ·	86.
wFS-24243	FRAM-PRESSURIZED STRUCTURE OPTIMIZATION	
RINGS		
F EM-11389	JET 1-ANALYSIS OF JET ENGINE BURST-ROTCE CONTAINMENT DEVICES	
RESK		73
MSC-19078	ADDITION CONVOLUTION COMPUTER PROGRAM FOR COST RESK ANALYSIS	13
REVER :		
COS-02533 UGA-02343	TIDEDA-TIME DEPENDENT DATA ANALYZER DOSAG L-SIPULATION OF WATER QUALITY II. STREAMS AND CANALS	54
READAM		71
ME2-15481	REACAM-SURPOLITING TO SOLVE DIFFERENTIAL EQUATIONS	•••
FOCKET ASHICT	ES .	
EFW-11747	COMPUTER PROCRAM FOR CALCULATION OF COMPLEX CHEMICAL EQUILIBRIUM COMPOSITIONS, ROCKET PERFORMANCE, INCIDENT AND FEFTETED SHOCKS, AND CHAPMAN-JOUCUET DETONATIONS REX-BENDTE ACCESS TERMINAL CIRCULAR FRAME COMPUTER PROGRAM	15 86
ROOTS OF FOU		
WOW_1078	Ans 4-RELECTMMMS APPROXIMATION LIBEARY S JAM-EICTMMPLUE ROUTINE BY STURM SEQUENCE METHOD	67 75
BOT AT ING BOD		
1EW-1103		57 66
ROTATING DIS	s	
WFS-2197	ATTINGS-AUTOMATED SHELL THEERY FOR PETATING STRUCTURES	86
ROTATING SHA	rts	
LEW-1191	CONTITED PROGRAM FOR CALCULATING CRITICAL SPEEDS OF ROTATING SHAFTS	60
ROTATION		

RESTRICE ALLOCATION

GSC-11039 AUTOMATED INPLT CATA PREPARATION

ROT	S BLACES		
	LEW-11796	FORTRAN PROGRAM FOR CALCULATING VELOCITIES IN THE MERIDIONAL PLANE OF A TURBONACHINE	
ROT	OR BLADES E	Tureomach (nerv)	
	LF#-13741	FORTRAN PROGRAM FOR CALCULATING VELOCITIES AND STREAMLINES ON A BLADE TO BLADE STREAM SURFACE OF	A :
	L FW-107A4 L FW-13789 L EW-11389	TANDEM BLADE TLRECMCHIFE FORTMAN IN PPOCRAM TO ESTIPATE THE OFF DISIGN PEPFORMANCE OF RADIAL INFLOW TURBINES VELOCITIES AND STREAMLINES ON A READE-TO-BEADE STREAM SURFACE OF A TURBOMACHEME JET 1-ANALYSIS OF JET ENCIRE RURST-POTOM CONTAINMENT DEVICES	
RUN	TIRE ICONF	TUTERS 9	
	CO\$-02251	PRINCETON-SEAT PRECENT PERFERMANCE HENITOR	20
RUN	SE-RUTTA RE	TKOD	
	LAR-11049	PROGRAM TO DETERMINE PADIATING MONADIAPATIC ENVISCED FLOW OVER A BLUNT BODY BY THE MET-400 OF	41
		AWINT-ACAMS MOLITON INTECRATION SUBPOUTINE READAM-SUBFOILTIME TO SOLVE DIFFERENTIAL EQUATIONS	. 7: 7:
SAF	ETY		
		ESATA-EXECUTIVE SURPROUTINGS FOR AFTERMENT TEMPERATURE ANALYSIS OF A MODILE GAS COOLED MUCLEAR REACTOR PROVER PLANT	18
		COLUMN ANALYSIS COMPLEX RAM-PELIABILITY INALYSIS MCCEL	56
SAL	ORS		
	t 4R-11569	SALDRS-STRUCTURAL AMALYSIS OF LAYERED OPTHOTROPIC RING STIFFENED SHELLS OF REVOLUTION, LINEAR STRESS ANALYSIS OPTION	s !
SAR	FC S		
	4FS-15307	SAMECS-STRUCTURAL AMALYSIS METHOD FOR EVALUATING CEMPLEX STRUCTURES	
SAM	ts.		
		SAMIS-STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM ECOC 6600 VERSEONS SAMIS-STRUCTURAL ANALYSIS AND PAIRIX INTERPRETIVE SYSTEM FUNITAC FLOS VERSIONS	81
5 A #	PLING		
		SPEARMAN RHO PULTIPLE RANK URDER COURFLATION FROGRAM GIPTRAN-GENERAL INFUT PROPABILITY TRANSLATUR	5.5
SAT	ELLITE ROTA	ROITI	
	400-13344	SPIN-FREE VIERATION ANALYSIS OF SPINNING SIPUCTURAL SYSTEMS	7.6
TAZ	EN 18 LAUR	NCH VENICLES	
-	-	RAM-RELIANTLITY INALYSIS MCCEL	•1
	TREE ING		•
3¢*			
		CSS-CHARACTER STRING SCARNER	12:
3CH	EDUL 1 NS		
		PROGLOGK-SLAC PREGRAM PERFERMANCE MENTOR CANS-COMPUTER ASSISTED NETWORK SCHEDULING SYSTEM	31
	GSC-11641	GENS-GENERALIZED EVALUATION MODEL SIMULATOR	31
	MF 5-71670	A GPSS MODEL FOR JOB PESCUPCE ALLOCATION	41
		PLANT SERVICES PECALL SYSTEP	4:
300	PE III	· · · · · · · · · · · · · · · · · · ·	
		SCOPE TITE-SYSTEM FOR COMPUTING OPERATIONAL PROPABILITY EQUATIONS	67
SEA	LS (STOPPE		
	Ltw-ittio	INVESTIGATION OF ISCTIFFEMAL COMPRESSIBLE FLOW ACROSS A ROTATING SEALING DAW GAS THRRING FACE SEAL THERPAL DEFORMATION AND COMPUTER PROGRAM FOR CALCULATION OF AXISYMMETRIC TEMPERATURE FIELD	51 61
	1 E W- [7 7 8 6	COMPUTER PROGRAM FOR CUAST-CNE-DIMENSIONAL COMPRESSIBLE FLOW WITH AREA CHANGE AND FRICTION-APPLICATION TO GAS FILM SEALS	• (
SEA	ACH PROFILE	: s .	
	#5C-10779 #5C-19423	MULTIPLE UTILITY COMPLTER PROGRAM INDICES AND CROSS REFERENCES FROM COMPUTER READARLE TEXT	21
see			
	HQN-10106	SEE-SYSTEMS EFFECTIVENESS EVALUATION COMPUTER PROGRAM	3;
SFL		SEMINATION OF INFORMAT	
		WINDRITY PUSIFIES CAPABILITIES FILE	•

EQUENC ING		
#SC-17547	CHANGE-FERTHAN IN DIGITAL PROGRAM CHANGE	29
EQUENTIAL ANA	LASIS.	
MSC-17484	CCHSTAT-A CCPPREFFNSIVE PROGRAM FOR TEXTUAL CONCORDANCES AND STATISTICS	2 3
EQUENTIAL COR	PUTERS	
₩5-19725	QSAM-VARIABLE LEACTH INFLT/CUTPUT ROUTINE	21
ERVICES		
KSC-10819 WFS-23071	LOGISTICS HAPEWAPE AND SERVICES CONTROL SYSTEM PETANN-RISED FETIMATED RETIMEMENT ANNULTY CALCULATION PROGRAM	41
SE SOP		
MSC-14853	SESOP-PROGRAM FOR SOLAP ENERGY HEATING SYSTEMS ANALYSIS	12
SET		
~FS-22997	A COMPUTERIZED SOLUTION OF THE REPNER-TREGGE METHOD ALGORITHM	43
SGT MOE'X		
65C-11612	SCINDEX-DS/JEC SYSTEM GENERATION CROSS REFERENCE INCEX	2
SHAFTS EMACHEN	IE ELEKENTSI	
LEW-11110	GAS TURBINE FACE SEAL THERPOL DEFORMATION AND COMPUTER PROGRAM FOR CALCULATION OF AXISYMMETRIS	60
LEW-11910	TEMPERATURE FIELD COMPUTER PROGRAM FOR CALCULATING CRITICAL SPEEDS OF ROTATING SMAFTS	6
SHCP		
070-00232	SHCP-SHIP HULL CHARACTERISTICS PROGRAM	71
EHELL THEOXY		
LAR-10736 MFS-23027	GECMETRICALLY NON-LINEAR ARALYSIS OF APRITARRILY LOADED SHELLS OF REVOLUTION STARSZS-SHELL THEORY AUTOMATED ROTATIONAL STRUCTURES (STATICS)	8
SHELLS ESTRUCT	TURAL FORMS)	
GSC-11797 LAR-10050 LAR-11109 LAR-11309 LAR-11590 MFS-21070 MSC-14749 MPO-11310	AUTOMATED INPUT DATA PREPARATION FOR NASTRAM SAMIS-STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM CODE 6600 VERSION) GEOMETRICALLY MONLINGAR STATIC AND DYNAMIC ANALYSIS OF APRITPARTLY LOADED SMILLS OF REVOLUTION COMPUTER PROGRAM FOR STRESS. VIBRATION, AND BUCKLING CHARACTERISTICS OF GENERAL SHELLS OF REVOLUTION SAMP STATICS-STRUCTURAL RETWORK ANALYSIS PACKAGE AND ASTROS-AUTOMATED SMELL THEORY FOR ROTATING STRUCTURES SOR-SHELLS OF REVOLUTION ANALYSIS PACKAGE CODE 6000 SERIES VERSION) SAMIS-STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM CUNIVAC 2108 VERSIONS	\$! \$! \$! \$!
SHIP HULLS		
000-00033	SHCP-SHIP MULL CHARACTERISTICS PROJEAN	7
SHIPS		
010-00041	MIDSHIP SECTION CESIGN FOR MAYAL SHIPS	7
SHOCK TUBES		
LEW-11467	GENERAL CHEMICAL KINETICS COMPUTER PROGRAM FOR STATIC AND FLOW REACTIONS WITH APPLICATION TO COMMUSTION AND SHECK TUBE KINETICS	1
SHROUDS		
	COMPUTER PRECRAM FOR CALCULATING POTENTIAL FLOW IN PROPULSION SYSTEM IMLETS	
SIGNAL MEALYS!	is	
MSC-17487	TELETANCE ANALYSIS PROGRAM	3
SIGPAC		
G5C-11499	SIGPAC-SIGNIFICANCE APITHMETIC EXPERIMENTAL PACKAGE	5
STRULATION		
010-00037 HFS-21670 HFS-21701 HPD-13522		3
SIME ATORS		
GSC-11505	POSINO-POWER SYSTEM SIMULATOR MONITOR	1

LFW-10413	FORTRAM 1V PROCRAM FOR SYMPOLIC SOLUTION OF UP TO 20 SIMILTANEOUS EQUATIONS MATAR-A CONVERSATIONAL APPROACH TO MATRIX CALCULATIONS-CONCEPTS AND EMPLEMENTATION AMINT-ADAMS WILLION INTEGRATION SURBOUTINE MAPIN SOLUTION OF LARGE SYSTEMS OF LINEAR EQUATIONS WITH RANDED. SYMMETRIC MATRICES ON THE TRANSVISION OF		68 51 70 71
SINEA 3G			
HSC-13805	SINCA 3G-SYSTEPS THPREVEE PUMERICAL DIFFERENCING ANALYZER SUNIVAC 1100 SERIES VERSIONS		**
SECURESS			
656-11395	PPOFAN-CPTICAL TESTON AND ANALYSIS		* \$5
SKIN (STRUCTUR	(4. MERBER)		
14R-10473	STOUCTURAL SYNTHESIS OF A STIFFENED CYLINDER		\$ }
SEA BEICHAHERE			
	A PROGRAM FOR COSPUTING THE BRIGHTNESS TEMPERATURE OF A CLEAR ATHOSPHERE FROM RADIOSONDE DATA		5 5
SLACHON			
	SLACHON-SLAC SCRIBARE MCALTON, VERSION 2-2		19
SHAC			
	SMAC-A NUMERICAL TECHNIQUE FOR CALCULATING INCOMPRESSIBLE FLUID FLOWS		5 3
SRIPS			
	SHIPS-SHALL INTERACTIVE IMAGE PROCESSING SYSTEM		5 5
SHAP DYNAMICS			
	SWAP DYNAMICS-STRUCTURAL NETWORK ANALYSIS PROGRAM		9.2
	Man Hidauft 3- Macrosoft without was a second of the secon		
SWAP STATIC	CANADA CTATES CTRACTION AND ANALYCIC PROCESS		93
	SNAP STATECS-STRECTURAL AFTWORK ANALYSIS PROCRAM		
SOFTWARE MONIT	•		19
	SLACHON-SLAC SOFTWARE MENTER, VERSION 2-2		
SOLAR COLLECTO			1
#SC-14851	SESEP-PREGRAM FOR SELAR ENERGY HEATING SYSTEMS ANALYSIS		-
SOL 105	THE		8
NUC-10049	COMPUTER PROCESH FOR THE STEADY-STATE TEMPERATURE ANALYSIS OF PLANE OR EXISYMMETRIC BOOIES		
509			•
MSC-14748 WSC-14749	SOR-SHELLS OF REVOLUTION APALYSIS PACKAGE CODE 6000 STRIES VERSIONS SOR-SHELLS OF REVOLUTION APALYSIS PACKAGE LIRM 360 SERIES VERSIONS		8
SOURCE PROGRA			. ,
450-27567	CHANGE-FORTERM IN DIGITAL PROGRAM CHANGE		•
SPACE LOGISTI	cs in the second of the second		
450-19116	LIGISTICS RESURPLY COPPLIER PROGRAM		٠
SPACE SHOTTLE	•		
MSC-17446 MSC-17931	FREA-FAILURE PLOE AND EFFECTS ANALYSIS INPUT/OUTPUT PROGRAM STRESS-STRUCTURAL THERMIL RAPID EVALUATION-STRESSES AND STRAINS		•
SPACECRAFT CO	NTROL		
NPG-11344	SPIN-FREE VIERATION ANALYSIS OF SPINNING STRUCTURAL SYSTEMS		1
SPACECRAFT EL	ECTRONIC EQUIPPENT		
HQN-10305	SEE-SYSTEMS EFFECTIVENESS EVALUATION COMPUTER PROGRAM		3
SPACECRAFT ST	RUCTURFS		
650-11194	WODAL METHORE THERMAL PALANCE PROGRAM		1
SPECIFIC HEAT			
NIC-10287	TAP-A-A PROCESH FOR COMPUTING TRANSIENT OR STEADY-STATE TEMPERATURE DISTRIBUTIONS		1
SPECTROSCOPE	ANALYSES		
NPO-11961	THREE BIT WASS SEECTRAL SEARCH PROGRAM		!
		٠.	
	10 STANIA CONTRACTOR		•

SPECIAUM MEALY	313	
GSC-11279	A COMPUTER PECGEAR FOR QUALITATIVE AND QUANTITATIVE ANALYSIS OF LOW-RESOLUTION WAS.	
SPHERES		
HQN-10677	ADVANCED STRECTURAL GEOPETRY STUDIES	80
SPIN		
MPO-13344	SPIN-FREE VIRPATION ANALYSIS OF SPINNING STRUCTURAL SYSTEMS	74
SPIN STABILIZA	TION	
NPD-13344	SPIN-FREE VIERATION ARALYSIS OF SPINNING STRUCTURAL SYSTEMS	74
SPLINE PURETIO	xs	
	FORTREN PROGRAP FOR SPLINE FIT CURVE FITLOS-FORTRAN PROGRAM FOR FITTING LOW-ORDER POLYNOMIAL SPLINES BY THE METHOD OF LEAST SQUARES SPLINT-PARABOLIC SPLINE INTERPOLATION SUBROUTINE	(60 61 74
SPLIKT		
NPO-10786	SPLINT-PARAPELIC SPLINE INTERPOLATION SUBROUTINE	74
SPRINGS CELAST	ICI	
MFS-13217	STRESS ARALYSIS OF BELLEVILLE SPRINGS PROGRAM	84
SSCOL		
KSC-10425	SSCOL-STATISTICAL SUMMARY OF CLIMATOLOGICAL DATA	52
STABILITY		
	DUTLIER TECHNICUE PROCRAP PANES-PROGRAP FOR ANALYSIS OF NONLINEAR EQUILIBRIUM AND STABILITY	7)
STAGNATION FLO	v	
LEW-10977	FORTRAM PROGRAM FOR CALCULATING TRANSONIC VELOCITIES ON A BLADE TO PLADE STREAM SURFACE OF A TURECMACHINE	4
STANDARD DEVIA	TICH	
	SSCCI-STATISTICAL SUMMARY OF CLIMATOLOGICAL DATA GIPTRAM-GENEPAL INPUT PECBERILITY TRANSLATOR	52 67
STANTON INDIBER		
MSC-14493	STANTON NUMBER-JEPODYNAPIC MEATING	
STARS2S		
MFS-23027	STARSES-SHELL THECRY AUTEMATED ROTATIONAL STRUCTURES ISTATICS:	
STATIC COADS		
L4R-1153)	GECMETO" CALLY REPLINES STATIC AND CYNAMIC ANALYSIS OF ARBITRARILY LOADED SHELLS OF REVOLUTION AND STATICS-STRUCTIONAL NETWORK ANALYSIS PROGRAM ANALYSIS PROGRAM TRANSPORT ACCESS TERMINAL CIRCULAR SPAME COMPUTER PROGRAM	81 83 86
STATECS		
MF5-23027	STARSES-SHELL THEORY AUTOMATED ROTATIONAL STRUCTURES ESTATICS	
STATISTICAL AN	ALYSIS	
	SSCOL-STATISTICAL SUMMARY OF CLIMATOLOGICAL DATA	52
MF 5-24103	ASAP-AN AUTOMATED STATISTICAL ANALYSIS PROGRAM TEMPO-TECHNIQUE FOR EVALUATING MULTIPLE PROBABILITY OCCURPENCES	32 72
MSC-14690 MSC-17486	ASTEP-ALGEPITHFIC STHULATION TEST AND EVALUATION PROGRAM CONSTAT-A COPPREHENSIVE PROGRAM FOR TEXTUAL CONCORDANCES AND STATISTICS	51
STATISTICAL DI	STRIBUTIONS	
HF 5-22 994	PROGRAM FOR STANCARD STATISTICAL DISTRIBUTIONS A COMMITTER PROGRAM FOR STANCARD STATISTICAL DISTRIBUTIONS CONSTAT-A COMPREHENSINE PROCRAM FOR TEXTUAL CONCRONCES AND STATISTICS	72 12 29
STATISTICAL TE		
	SIGPAC-SIGNIFICANCE ARITHMETIC EXPERIMENTAL PACKAGE	
STATISTICS	The state of the s	••
HQN-10476	SCHRET-BELLCCUP INFORMATION RETRIEVAL SYSTEM GIPTRAM-CENERAL IMPUT PROMABILITY TRANSLATOR	24
STEADY FLOW		24
-	PROCRAM TO DETERMINE RECIPTING MONADIABATIC INVISCID FLOW OVER A BLUNT RODY BY THE PETHOD JE	40

STEADY STATE		
LEW-11110	GAS TURBINE FACE SEAL THERPAL CEFORMATION AND COMPUTER PROGRAM FOR CALCULATION OF AXISYMMETRIC TEMPERATURE FIELD	. 50
HFS-15055 HUC-10049 HJC-10189	BITA IT-POFINC ENGINEERING THERMAL ANALYZER COMFUTER PROGRAM FOR THE STEADY-STATE TEMPERATURE ANALYSIS OF PLANE OR AXISYMMETRIC BODIES TRACK-COMPUTER PROGRAM FOR TRANSIENT AND STEADY STATE COUPLES FLUID FLOM AND MEAT COMFUCTION	93 95
NUC-10282	ANALYSIS TAP-A-A PROGRAM FOR COPFLITING TRANSIENT OR STEADY-STATE TEMPERATURE DISTRIBUTIONS	95
STEAM		
10000-000	STMTAR-SURRCLTINE FOR THE THERMODYNAMIC PROPERTIES OF STEAM AND WATER	91
STEP FUNCTIONS		
4FS-13122	DENCRO-SCLUTICA OF DIFFERENTIAL EQUATIONS USING THE HORDSTECK METHOD	71
STICAP		
LAR-11184	STICAP-LINEAR CIRCUIT ANALYSIS PROGRAM WITH STIFF SYSTEMS CAPABILITY	33
STIFFENING		
LAR-10473	STRUCTURAL SYNTHESIS OF A STIFFENED CYLINDER	80
STIFFHESS		
LAR-1005) LAR-11569	SANTS-STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM ECOC 6600 VERSION) SALORS-STRUCTURAL ANALYSIS OF LAYERED OPTHOTROPIC RING STIFFENED SHELLS OF REVOLUTION, LINEAR SIRESS ANALYSIS EPTICA	*3
WFS-21493 MSC-17617 MPD-11319 MPD-11555	PPGGRAM TO RELUCE THE SIZE OF STRUCTURM MATRICES SAMIS-STRUCTURAL ANALYSIS AND MOTETY INTERPRETIVE SYSTEM (UNIVAC 1108 VERSION) ELASA-COMPUTER PROGRAM FOR LINEAR EQUILIRATUM PROBLEMS OF STRUCTURES	85 88 89
STRTAS	WAVEFRONT-STRUCTURAL STIFFRESS MATRIX WAVE FRONT RESEQUENCING PROGRAM	••
	STMTAB-SUBROUTINE FOR THE THERMODYNAMIC PROPERTIES OF STEAM AND WATER	. 91
STRENACS	Similar 2000001146 tou the resumminate tunkenises of Siena and Marke	•
	STRUMACS-US/360 ASSEMBLY LANGUAGE STRUCTURED PROGRAMMING MACROS	23
		• • •
STREAM FUNCTION	MAGAFY-FORTIAN PROGRAM FOR CALCULATING VELOCITIES IN A MAGNIFIED REGION ON A BLADE TO READE SURFACE	
LFW-10777	OF A TURE CHARMENT FOR CALCULATING TRANSPHIC VELOCITIES ON A 8: ADE TO BLADE STREAM SURFACE OF A TERROMACHINE	•
STREAML INING		
LFW-10471	ANALYSIS OF CECHETRY AND DESIGN POINT PERFORMANCE OF AXIAL FLOW TURBINES	3
STREAMS		
LEW-12376	CALCULATION OF SUPERSONIC STREAM PAPAMETERS OF A REAL GAS FROM MEASURABLE QUANTITIES USING FORTRAN.	. 49
STRESS		
450-17431	STRESS-STRECTERAL THERMAL PAPED EVALUATION-STRESSES AND STRAINS	8 6
STRESS ANALYST	s in the second	
MFS-02227 MFS-1321/ MPO-11943	COLUMN ANALYSIS COMPLEX STRESS ANALYSIS OF BELLEVILLE SPRINGS PROGRAM CONTRAKESTRICTURAL EFSICA AND STRESS ANALYSIS PROGRAM FOR ADVANCED COMPOSITE FILAMENT-MCCMD ARISMMETRIC PRESSURE VESSELS	84 84
M1C-E0347		₹0
STRESS CYCLES		
	RECENERATIVE CCOLING DESIGN/ANALYSIS COMPUTER RPOGRAM FRACTURE RECHARICS EVALUATION OF TI-6A1-6V PRESSURE VESSELS	23 \$7
STRESS-STRAIN		
	CAPP-COMFRESSION ALLOWARDE PLOTTING ROUTINE SIRESS-STRUCTURAL THERMAL PAPID EVALUATION-STRESSES AND STRAINS	6 7 R 8
STRESSES		
MN-00041 148-11367 148-11569	SALORS-STRUCTURAL ANALYSIS OF LAYERED ORTHOTROPIC RING STIFFFNED SHELLS OF REVOLUTION, LINEAR	79 51 83
LAR-[1696	STRESS APALYSIS COTION NICLANI-A COMPLTER POCCHAM FOR INSTABILITY ANALYSIS OF LAMINATED LONG PLATES SUBJECTED TO COMPINED	9.3
WFS-23648 WF5-26034 WFS-24042	IMPLANE LOADS TOPSION ANALYSIS OF OPEN SECTIONS APROCE-APPORTICAPENT/PRECICTION APROFENITATION FOR ACCULAR FRAME COMPUTER FROGRAM	84 57
	SAAP-PRESSURTER STEP STRUCTURE OPTIMIZATION	44

STR	ESSES		
		FMA-FRAME MCCAL ANALYSIS STRESS-STRUCTURAL THERMAL PARID EVALUATION-STRESSES AND STRAINS	18
STR	atorn th	LYSIS	
	COS-02350 DD0-00036 DD0-00038 DD0-00038 CSC-11039 HQM-10677 LAR-10750 LAR-11350 LAR-11350 LAR-11550 HFS-20648 HFS-20648 HFS-20648 HFS-20648 HFS-2172 HSC-14748 HSC-14748 HSC-17031 HSC-17313 HSC-17313	PASFLAY-FIRITE ELEMENT PESH GENERATION PROCRAM TOWER 12-GUYER TOWER ANALYSIS COMPUTER PROGRAM GENERAL PURPOSE CYERLAY ICAGER FOR COC GOOD STRIES COMPUTERS ALITMATED INFIT LAT. PRE-RAPATION FOR NASTSAN ALITMATED INFIT LAT. PRE-RAPATION FOR NASTSAN ALITMATED STRUCTURAL ANALYSIS AND NATARX INTERPRETIVE SYSTEM (CDC 6600 VERSION) COMPUTER PROGRAM FOR ITRESS, VIGRATION, AND EUCKLING DIAFACTERISTICS OF GENERAL SHELLS OF REVOLUTION SHAP DYNAMICS-STRUCTURAL PETADRA WANLYSIS PROGRAM SALPOSIS-STRUCTURAL ANALYSIS OF LAYERED ORTHOTROPIC PING STIFFENED SHELLS OF REVOLUTION, LINEAR STRESS ARLLYSIS COFICE SANCES-STRUCTURAL ANALYSIS METHOD FOR EVALUATING COMPLEX STRUCTURES TORSION ANALYSIS OF OPEN SECTIONS PANES-PROGRAP FOR ANALYSIS OF NONLINEAR EQUILIBRIUM AND STABILITY SCH-SHELLS OF REVOLUTION ANALYSIS PACKAGE (CDC 6000 STRIES VERSION) SCH-SHELLS OF REVOLUTION ANALYSIS PACKAGE (CDC 6000 STRIES VERSION)	772280088822 4444772288888 844477
		MAYEFRONT-STRUCTURAL STIFFNESS MATRIX MAYE FRONT RESEQUENCING PROGRAM	17
STR	000-00033 000-00035 000-00041 000-00053 000-00054 LAR-10473 MFS-21432	SHOP-SHIP MULL CHARACTERISTICS PROGRAM PAHOIT-STRUCTURAL MATRIX BARDHIDTH REDUCTION COMPUTER PROGRAM, COC 6000 SEPIES VERSION PAHOIT-STRUCTURAL MATRIX BARDHIDTH REDUCTION COMPUTER PROGRAM, SEM-360 VERSION MIDSHIP SECTION CESION FOR NAVAL SHIPS CRICZD-1FFS-THOC INTENSIONAL GRID GENERATOR AND TERMINAL CONTROL SYSTEM OF THE INTERACTIVE GRAPHICS FINITE ELEMENT SYSTEMS RANDIT-STRUCTURAL PATRIX BARDHIDTH REDUCTION COMPUTER PROGRAM, HONEYHELL VERSION STRUCTURAL PATRIXSIS OF A STIFFENCE CYLINDER	76 74 76 79 79 79 79
STR	UCTURAL ENG	INSERING	
-	D-3D+00034 D-3D-30035	MANDIT-STRUCTURAL MATRIX RANDWIDTH PEDUCTION COMPUTED PROGRAM, CCC 6000 SERIES VERSION RANDIT-STRUCTURAL MATRIX BANDWIDTH REDUCTION COMPUTE, PROGRAM, IEM-360 VERSION BANDIT-STRUCTURAL MATRIX RANDWIDTH REDUCTION COMPUTER PROGRAM, UNIVAC 1108 VERSION RANDIT-STRUCTURAL MATRIX RANDWIDTH REDUCTION COMPUTER PROGRAM, MONEYMELL VERSION	7 6 7 1 7 5 7 6
STR	UCTURAL STA	BILITY	
		COLUMN ANALYSIS (CMFLEX ELASB-COMPUTER PROGRAM FOR LINEAR EQUILIBRIUM PROPLEMS OF STRUCTUPES	89
STR	UCTURAL STR	AIN	
	LAR-11696	RUCLAP2-A COMPLETER PROGRAM FOR INSTABILITY ANALYSIS OF LAMINATED LONG PLATES SIFIECTED TO ID49 INED INPLAME LOADS	83
STR	OCTURAL VIE	RATION	
	MF 5-21432	COMPUTER PROCPAM FOR STRESS. VIBRATION. AND BUCKLING CHARACTERISTICS OF GENERAL SHELLS OF REVOLUTION VIBRATIONAL TRANSFER FUNCTIONS FOR PASE EXCITED SYSTEMS FMA-FRAME MCCAL AMALYSIS	6 1 15 6 2
STU	院 規		
		STUPM-FIGENVALUE ROUTINE BY STURM SEQUENCE METHOD	15
SUB		MARIES (CCMPUTERS)	
		ALTEIN-AUTCHATIC COMPUTER SUSPENGRAM SELECTION FROM APPLICATION PROGRAM LIBRARIES ODINEX-OPTIPAL CESTON INTECRATION EXECUTIVE PROGRAM	26
SUB	ROUT THE S		
	LAR-11124	CENTRAL PURPECSE EVERLAY LOACER FOR COC 6000 SERIES COMPUTERS ALTLIA-AUTHMATIC COMPLTER SURPRIGRAM SELECTION FROM APPLICATION PROGRAM LIBPARIES A SET OF FORTEM IV SLEPCLITYES FOR GENERATING PRINTED PLOTS RKATAM-SLERCLTIME TO SCLVE CIFFERENTIAL EQUATIONS	2 2 2 2 2 1
SUB	SCHIC FLOM		
	LAR-11 048	PROGRAM TO CETERPINE RACIATING MONACIABATIC INVISCID FLOW DYER A BLUNT BODY BY THE METHOD OF INTEGRAL RELATIONS	•
	LAR-11247 LAR-11305	THEOPETICAL PROTICTION OF INTERFERENCE COADING ON AIRCRAFT STORES-SURSCNIC CASC AN IMPONED RETMOD FOR THE AERODYNAMIC ANALYSIS OF WING-RODY-TAIL CONFIGURATIONS IN SUBSONIC AND SUPPRONIC FICM	3
	LFW-10764 LFW-10789	FORTRAN LY FRECRAM TO ESTIPATE THE OFF PESIGN PERFORMANCE OF REDIAL INFLOW TURBINES MAGNEY-FORTRAN PPOGRAM FOR CALCULATING VELOCITIES IN A MAGNIFIED REGION ON A BLADE TO BLADE SURFACE	3
	LFW-11013	OF A TURFOMACHINE INVESTIGATION OF ISCTHERMAL COMPRESSIBLE FLOW ECROSS A ROTATING SEALING DAM	59

SUBSONIC FLOW		
TEM-15386	COMPUTER PROCESS FOR QUASI-ONE-DIMENSIONAL COMPRESSIBLE FLOW WITH AREA CHANGE AND FRICTION-APPLICATION TO GAS FILM SEALS	
SUBSONIC SPEED		
L4R-11047	WIRTER LATTICE FORTRAM FEGGRAM FOR ESTIMATING SUBSOMIC ACRODYNAMIC CHARACTERISTICS OF COMPLEX PLANFORMS	1
SUBSTRUCTURES		
MFS-71437	VIRANTIONAL TRANSFER FUNCTIONS FOR PASE EXCITED SYSTEMS	15
SURMARIES		
	SCIENTIFIC PACKETIC TAPE LIGIARY SYSTEM	37
SUPERSONEC		
CAR-11305	AN IMPROVED METHOD FOR THE AERODYMAMIC ANALYSTS OF WING-BODY-TAIL CONFIGURATIONS IN SUBSONIC AND SUPPRSONIC FLEW	2
SUPERSONIC CON		
	CALCULATION OF SUPERSONIC STREAM PARAMETERS OF A REAL GAS FROM MEASURABLE QUANTITIES USING FORTRAN	49
SUPERSONIC FLO		
	COMPUTER PROGRAM TO DETERMINE PRESSURE DISTRIBUTION AND FORCES ON PLUNT BODIES OF REVOLUTION THEORETICAL PREDICTION OF INTERPERENCE LIBBING ON AIRCRAFT STORES—SUPERSONIE CASE	1 6 2
SURFACE PROPER	TIES	
t =w-104 m2 t2w-107 m9	PLOTSO-A PACKACE OF FORTBAN SUBPROGRAMS TO DRAW THREE DIMENSIONAL SURFACES. MAGNEY-FERTBAN PROGRAM FER CALCULATING VELOCITIES IN A MAGNIFIED REGION ON A CLADE TO BLAVE GURFACE.	27 4
LFW-11635	OF A TURISMACHINE CHARL-FERTRIA PEOGRAM FOR CUASI-THREE-DIMENSIONAL CALCULATION OF SURFACE VELOCITIES AND CHOKING FLOW FOR TURISPACHIAE BLADE ROWS	, 5
SURGES		
MPR-11494	MTRAC-COPPLTER PROGRAM FER ANALYSIS OF CIRCUITS INCLUDING MACHETIC CORES	35
SWITCHES		•
LAR-11210	DESIGN OF MECACSTRIP COMPCANIS BY COMPUTER	33
SYMBOLIC PROGR	LAPMING	
	FORTAP-A GENERALIZED FORTHAN TAPF CONVERSION PROGRAM CAPS-SOURCE CFCK COMPRESSION AND UPDATE PROGRAM	22 22
SYMBOLS		
GSC-11787	CSS-CHARACTER STRING SCANNER	23
SYSTEM EFFECTS	VENESS	
KFS-16499	GEMS-GENERALIZED EVALLATION MODEL SIMULATOR EXACT MINIMAL PATH AND MINIMAL CUT TECHNIQUES FOR DETERMINING SYSTEM RELIABILITY ENSION-RELIABILITY GOAL STATUS	39 62 62
SYSTEM FAILURE	85	
MSC-17446	FMEA-FAILLPE PCDE AND EFFECTS ANALYSIS ENPUT/OUTPUT PROGRAM	43
SYSTEMS AHALYS	us ·	
	MGPSS-NACC GENERAL PURPOSE SIMULATION SYSTEM FOR CDC 6000 SERIES COMPUTERS	38
GSC-11641 15W-11815	GFMS-SENFRALIZED EVALUATION MODEL SIMULATOR COMPUTER PROCESAM FOR PRELIPINARY DESIGN ANALYSIS OF AXIAL FLOW TUPBINES	39 5
MFS-22672 MFS-24036	MARSYAS-MADSHALL SYSTEM FOR AFROSPACE SIMULATION APROCT-APPORTICNMENT/PREDICTION	43 62
MFS-24171	ERSION-RELIABILITY GCAL STATUS	52
	MTREAC-CHIPCITEP PPRORUM FEP ANALYSIS OF CIRCUITS INCLUDING MAGNETIC CORES	35
	MORCANTOWN MASS TRANSIT SIMULATION MODEL COMPUTER PROCHAM CALCULATES PIPING-SYSTEM PARAMETERS	44 50
	TPACE-TREE ANALYSIS CODE	63
SYSTEMS FAGINE	CERTING	
	MCPSS-MADE GENERAL PURPOSE SIMULATION SYSTEM FOR CDC 6000 SERIES COMPUTERS	36
	GEWS-GENFHALTIFD FYALLATION MODEL SIMULATOR COMMUTER PROGRAM FOR PRELIMINARY DESIGN ANALYSIS OF AXIAL FLOW TURBINES	39
	FMEA-FAILURE MODE AND EFFECTS AMALYSIS IMPUT/CUTPUT PROGRAM	43
TABLES IDATAL		
	COMPUTER PROCPAN TO MERGE AND/OR MODIFY TABLICAR DATA	28
490-11940	THREE BIT MASS SPECTRAL SEARCH PROGRAM	15

TANULATION PRO	ICESTES	
	THE SELECTION OF APPROXIMATING FUNCTIONS FOR TABLIATED MIMERICAL DATA	12
TAKEOFF		
455-21873	TAKEOFF AND LANDING PEPECPHANCE	42
TAKEOFF RUNS		
455-21573	TAKEOFF AND LANDING PERFEPHANIE	42
TAP-A		
MUC-13282	TAP-A-A PROGRAM FOR COMPLETING TRANSIENT OR STEADY-STATE TEMPERATURE DISTRIBUTIONS	95
TASKS		
MSC-17451	PECOND OF TASK PROGRESS	43
TEMPERATURE		-
	MANAL RETURNS THERMAL BALLAGE BROCKER	. 91
16H-11591	NODAL NETWORK THERMAL BALANCE PROGRAM FSATA-FRECUTIVE SURROUTINES FOR AFTERHEAT TEMPERATURE ANALYSIS OF A MOBILE SAS ICCLED NUCLTAE REACTOR POWER PLANT	12
TEMPERATURE DI	STREETION	
	TIDEOA-TIME CEPERCENT DATA ANALYZE?	66
EEW +1117	GAS FURBINE FACE REAL THERMAL DEFORMATION AND COMPUTER PROGRAM FOR CALCULATION OF AXISEMMETRIC TEMPERATURE FIELD	60
LFW-17110 MFS-21075	PEGENERATIVE CONTING CESTCR/ANALYSIS COMPUTER REPOSERM RAVEAC-REDIATION VIEW FACTOR PROGRAM	· +3
400-10049	COMPUTER PROGRAM FOR THE STEADY-STATE TEMPERATURE ANALYSIS OF PLANE OF RETSYMMETRIC MODIES TRANSCRIVES AND STEADY STATE COUPLED FLUID FLOW AND MEAT CONDUCTION ANALYSIS ANALYSIS	95
NUC-10241 NUC-10282		95 55
TERPO		
WF5-24103	TEMPO-TECHNIQUE FOR EVALUATING MULTIPLE PAGRABLETY CCCURRENCES	7.2
TENSILE STRESS		
MFS-12641	BELLOWS CALCULATION PROCRAP	61
TENSOR AMALYST	\$	•
000-00024 000-00025 000-00026	MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM LIRM 7094 VERSION) MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM LUNIVAC LICA VERSION; MEL 21-PIPE FLEXIBILITY ANALYSIS PROGRAM LOCO ADDO SERIES VERSION;	78 78 78
DD-03027	WEL 40-PIPING FLEXIBILITY AMELYSIS PROGRAM	70
	CANADA A COMPANY CONTROL FOR STABLE CANADANA CANADANA CONTROL	• •
	CONSTAT-A COMPRESENSIVE PROCESAM FOR TEXTUAL CONCORDANCES AND STATISTICS	23
THERMAL ANALYS		
45C-13805	SINGA 3G-SYSTEMS IMPROVED NUMERICAL DIFFERENCING ANALYZER TUNIVAC 1100 SERIES VERSIONI	34
THERMAL CONDUC	TORS	
02 C-1 + 204	MIGHTHICK-A COMPUTER PROGRAM THAT NIMERICALLY INTEGRATES THE DIFFERENTIAL EQUALIONS THAT DESCRIBE THE HYDPODYNAPICS OF A LIPCE CLASS OF HEAT PIPES	47
THERMAL ENERGY		
LEW-11854	ACMA-AFRETHEFF CHARRING PATERIALS APLATICH COMPUTER PROGRAM	77
THERMAL INSULA	FION	
4F 5-15149	THERMAL ANALYSIS IT FLUID FLIM IN A PEPE	73
THERMAL PROTEC	TION	
450-17931	STOFFS-STOLETIFFF THEFFIL PADID EVALUATION-STORESES AND STORES	
THERMAL STABLE	· · · · · · · · · · · · · · · · · · ·	
	WOORL METHER THERMAL MALANCE PROCERAM	91
THERMAL STRESS		٧,
		•-
000-00025	MEL 21-PIPE FLEXIBILITY ANALYSIS PREGRAM FIRM 7096 VERSIEN) MEL 21-PIPE FLEXIBILITY ANALYSIS PREGRAM FUNIVAC 1108 VERSIENI	71
	MFL 21-PIPF FLFXIPILITY APALYSIS PROGPAN LCDC 6000 SFRIES VERSION) MFL 43-PIPINC FLFXIFILITY APALYSIS FROGRAM	1 H
	META (1-MOFING FACINEED ING. THERMAL ANALYZED	2.1
THEPHOCHEMISTS	Ψ	
	ACE-AFPOTERM CEFMICAL ECUILIBRIUM COMPUTER PROCRAM ACE-AFPOTMERM CHEMICAL ECUILIBRIUM COMPUTER PROCRAM	16

INCHACCETAES		
LEW-11110	GAS TURRINE FACE SEAL THERPAL DEFORMATION AND COMPUTER PACGRAM FOR CALCULATION OF AXISYMMETRIS TEMPERATURE FIELD	60
1 HARY COMABHT	CYCLES	
	COMPUTER PROGRAM FOR CESTED POINT PERFORMANCE OF TURPOJET AND TUFFORM ENGINE CECLES. WASP-A FLEXIBLE FORTRAM IN COMPUTER CODE FOR CALCULATING HATEP AND STEAM PROPERTIES LIBM VERSIONS.	93
THERMODYTIME	EFFICIENCY	
LEW-12008	PROGRAM FOR CALCULATING TOTAL-EFFICIENCY SPECIFIC-SPEED CHARACTERISTICS OF CENTRIFUGAL COMPRESSIONS	51
THERRODYNALIC	EQUIL 1381UM	
NUC-10149 NUC-10169	CCMPUTED PROCRAM FOR THE STEADY-STATE TEMPEPATURE ANALYSIS OF PLANE OR AXISYMMETRIC RODIES TRAISE-COMPUTED PROGRAM FOR TRAISIENT AND STEADY STATE COUPLED FRUID FROM AND MEAT CONDUCTION AMARYSIS	95 75
	TAP-A-A PROGRAP FOR COMPUTING TRANSIENT OF STEADY-STATE TIMPERATURE DISTRIBUTIONS	75
THERMODYNAMIC		
LFW-13254 LFW-11629 LFW-11743	STATA-SLARCITIME FOR THE THERMODYNAMIC PROPERTIES OF STEM AND WATER FORTRAM IN PRIGRAM FOR CALCULATION OF THERMODYNAMIC DATA GASP-A COMPLIER COOF FOR CALCULATION THE THERMODYNAMIC AND TRANSPORT PROPERTIES FOR EIGHT FRUIDS-MELTUR, PETHARS, MECHANITROKEM, CARBOTH MERCH, CRYCEM, ARGUNICAR ROW DITH LIBM-TORM VERS COMMITTER PROPERM FOR CALCULATION OF COMPLEX CHEMICAL EQUILIBATION COMPOSITIONS, RICKET PERFORMANCE, INCIDENT AND REFLECTED SICKS, AND CHAPMAN-JOUGUST DETINATIONS	91 92 92 18
	MASP-A FLETTIRLE FORTRAN TO COMPUTER COOF FOR CALCULATING WATER AND STEAM PROPERTIES LIBM VERSIONS CALCULATION OF SUPERSONIC STREAM PARAMETERS OF A REAL GAS FROM MEASURABLE QUANTITIES USING FURTRAN LIV ROUTIAGES	49
426-14144	PHASE CHANGE SUBPOUTING FOR USE WITH FINITE DIFFFFFACING PROGRAMS	94
THEPRODYNAMIC	· Control of the cont	
LEW-12206	STMIAN-SUMBOLITHE FOR THE THERMORYMANIC PROPERTIES OF STEAM AND WATER MASPHA FLEXIPLE FORTRIM IV COMPUTER CONE FOR CALCULATING WATER AND STEAM PROPERTIES GIBM VERSIONS SIMPLIFIED FLUID SYSTEM THERMAL ANALYSIS	91 73 93
THICK WALLS		
148-10794	GENERAL TRANSIENT HEAT TRANSFER COMPUTER PROGRAM FOR THERMALLY THICK WALLS	91
THIN WALLED S	·ecus	
HFS-13217	STRESS ANALYSIS OF PELLEVILLE SPRINGS PROGRAM	. 64
THEH WALLS		
MFS-20649	TORSION ANALYSIS OF COEA SECTIONS	84
THREE DIMENSI	DMAL FLOW	
1 FW-11635	CHANEL-FORTRAN PROGRAM FOR QUASI-THREE-DIMENSIONAL CALCULATION OF SURFACE VELOCITIES AND CHOKENS FLOW FOR TURBOMACHINE BLADE ROWS	5
THROATS		:
4PO-10895	MIMERICAL SCLLTICH OF TRANSONIC FLOW IN A CONVERGENT-DIVERGENT WOZZLE	50
THRUST BEARING		
LF#-11511	EVALUATION OF POTATING INCOPPRESSIBLY LUPPICATED PRESSURIEFO THRUST REAPINGS	50
TEDEDA		
COS=02>33	TIDEDA-TIME CEPENCENT DATA AVALYZED	56
TEME MEASUREM	ENT	
COS-02251	PROGLOGE-SLAC PROCRAM PRAFERMANCE MONITOR	50
TIME SERIES 4	CALYSIS	
Cns-02533	TICEDA-TIME CEPENCENT CATA ANALYZER	56
TOLERANCES EN	ECHAMICS)	
45C-17487	TOLERANCE ANALYSIS BONGBAM	35
TOPOGRAPHY		
	CENERALISEC CICITAL CENTEURING PROGRAM	25
TOPOLOGY		
1 F H= 1 7667 WFS = 1 3 196 WFS = 1 96 91 WSC = 1 70 31	PUZZLE-CCMPUTER JIDED EFSICN OF PRINTED CIRCUIT ARTMOUN ECAM-ELECTRONICS CIRCUIT ANALYSIS DROCRAM ECOC VERSION) ECAM-ELECTRONIC (IRCUIT ANALYSIS DROCRAM EIRM VERSION) NETWORK PATH FECCRAM GEOMETRY PROCESSES, MISS TOMILOGY AND MODAL POINT CENERATOR ECAM-ELECTRONIC CIRCUIT ANALYSIS PROGRAM EMBIVEC VERSION)	32 34 34 43 87
7001-11417		3.6

the second second		
TORSIONAL STRE	ss	
MFS-20648	TORSION ANALYSIS OF OPEN SECTIONS	34
TORSIONAL VISA	ATION	
MFS-01489	TORSICHAL VEEPATION NATURAL FREQUENCIES PROGRAM	\$3
TOWER 12		
000-00036	TCHER 12-GUYEE TCHER ANALYSIS COMPUTER PROGRAM	79
TOWERS		
D20-00036	TCHER 12-GUYEE TCHEP ANALYSIS COMPUTER PROGRAM	7.7
TOXIC HAZARDS		
MF 5-21114	MANCEDOK FOR ESTIMATING TOXIC FUEL MAZAROS	52
TRACE		
NUC-10402	TRACE-TREE ANALYSIS CCDE	53
TRACING		
NPN-11892	AIPPOL-WINE TRAJECTORY TRACING FOR AIR POLLUTION STUDIES	53
TRACK		
NUC-10189	TRACK-CCUPUTER PROGRAM FOR TRANSIENT AND STEADY STATE COUPLED FLUID FLOW AND HEAT CONDUCTION ANALYSIS	25
TRACKING EPOSE	TICHI	
	DERTI-OPTICAL TYSIEPS PAY TRACING OPDERN-OPTICAL CESSON AND ANALYSIS	55 55
TRANSCENDENTAL	FUNCTIONS	
NPO-1361+	VERGE-A DIGITAL COMPUTER SUBDUTINE TO ACCELERATE THE COMPERGENCE OF ITERATIVE PROCESSES	74
TRANSFER FUNCT	TORS	
#F5-21432	TICAP-LINEAR CIRCUIT ANALYSIS PROGRAM MITH STIFF SYSTEMS CAPABILITY "PP-CUNTPOL FECGRAM DETERMINES MINIMUM PHASE FROM VARIABLE GAIN CHAPACTERISTICS VIRRATIONAL TRANSFER FUNCTIONS FOR BASE EXCITED SYSTEMS HP-65 EMULATOR	33 34 85 29
TRANSFORMATION	IS EPATHEMATICS)	
MF 5-02 4 AS	PCINT TRANSFERMATICH-CRITCCRAPHIC TO PEPSPECTIVE, FORTPAM H VEPSION FOR 360 SYSTEM USE	70
TRANSFORMERS		
LFW-10299	PCHER SUPPLIES USING FICH FREGJENCY MODULES	- 11
TRANSIENT HEAT	TING THE	
MF 5-15055	GENERAL TRANSIENT HERT TRANSFER COMPUTER PROGRAM FOR THERMALLY THICK WALLS AFTA II-FORTRO FROINEFRING THERMAL ANALYZER TRACK-COMPUTER PROCRAM FOR TRANSIENT AND STEADY STATE COUPLED FLUID FLOW AND MEAT CONDUCTION ANALYSIS	91 93 95
TRANSTENT RESP	ONSE	
LAR-11 049	COMPUTER POCCEAN FOR THE TRANSIENT PESPONSE OF ARLATING AXISYMHETRIC BODIES INCLUDING THE EFFECTS OF SHAPE CHANGE	92
MES-1500?	TAP-A-A PRIGGRAM FIR COMPUTER PROSPAM FIR TRANSIENT ANALYSIS OF ELECTRONIC CIRCUITS TAP-A-A PRIGGRAM FIR COMPUTING TRANSIENT OR STEADY-STATE TEMPERATURE DISTRIBUTIONS	34 75
TRANSLATING		
	FORTRAM ANALYZER UMELP-UMINFR:ITY CF HOLSTCK EASY LIKEAF PROGRAMMING SYSTEM	23 73
TRANSLATORS		
C05-02520	FORDAM ANALYZER Extram—Expression translator Automato infet cata frefaration for hastran	20 21 93
TRANSMISSION &	INES	
L43-11210	NESIGN OF MICROSTRIP COMPCRENTS BY COMPUTER	23
TRANSONIC FLOW		
LEW-10977	FORTPAN FREGRAM FOR CALCULATING TRANSPINIC VELOCITIES ON A BLADE TO BLADE STREAM SURFACE OF A	. 4
NPO-10895	TUPPOMACHINE ALMERICAL SOLLTICA OF TRANSONIC FLOW IN A CONVERGENT-DIVERGENT NOIZELE	55

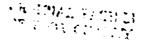
TRA	MSPORT PROP	EPTIES	
	LEW-11629	GASP-A CEMPUTER CODE FOR CALCULATING THE THEPMODYNAPIC AND TRANSPORT PROPERTIES FOR EIGHT FULLDS-HELLUM-HELMERN-EIN-EN-HITROGEN-CARLON MONDELEXUEN-SEGON-CARRON DIOK LIBM-1394 VERI	. 92
	LEW-12206	WASP-A FLEXIFLE FORTRAN IV COMPUTER CODE FOR CALCULATING WATER AND STEAM PROPERTIES (IBM VERSION)	*3
TRA	RSPORTATION		
	MFS-14513	RAM-RELIABILITY BRALYSIS MCDEL	, 51
TRE	ES (MATHERA	11051	
	MFS-18691 NPO-13304	FRACT MINIPAL FATH AND PERIMAL CUT TECHNIQUES FOR DETERMINING SYSTEM RELEABILITY NETWORK PATH PROCESS PELIABILITY COPPLYATION FROM RELEABILITY BLOCK DESCRANS TRACE—TREE SPALYSIS CODE	40 75 63
TRI	MOLES		
	HON-10677	ADVANCED STRICTURAL GEOFFRY STUDIES	
TRI	CONDRETE IT.	FUNCTIONS	
		HP-65 EMLLATCE	4.8
•••			• • •
141	M (BALANCE)		
	060-00030	SHCP-SHIP HULL CHAPACTERISTICS PROGRAM	. 78
TUR	BINE BLADES		
	LEW-10743	COMPUTER PROGRAM FOR CALCULATING FLOW DISTRIBUTION IN A RADIAL-INFLOW TURBINE FORTRAN FROGRAM FOR CALCULATING VELOCITIES AND STREAMLINES ON A PLADE TO BLADE STREAM SURFACE OF A TANCEM BLACE TURICMACHIAE	3
TUR	BINE PURPS		
	LEW-11516	COMPUTER PROCPAMS FOR PRECIOTING TUREOPUNP INDUCEP LOADING, STRESS MAGNITUDE, DISTRIBUTION AND VIGRATION CHAPACTERISTICS	". ♦
TU	BINES		
	LFW-10471 LFW-10764 LFW-11029	ANALYSIS OF CECHFIRY AND DESIGN POINT PERFURMANCE OF AKTAL FLOW TURBINES FORTRAM IV PACCRAM TO ESTIMATE THE OFF DESIGN PERFORMANCE OF RADIAL INFLOW TURBINES ANALYSIS OF CECHFIRY AND CESSION POINT PERFORMANCE OF AXIAL FLOW TURBINES USING SPECIFIED MERIDIONAL VELOCITY GRADIENTS	3
	MSC-19178	DUCT-ACTARATIC COMPRESSIBLE FLOW DUCT ANALYSIS PROGRAM	30
TUR	80CD##RESS0	RS	
	LEW-10765	COMPUTER PRECEARS FER ARIAL FLOW CUMPRESSOR DESIGN	3
TUR	BOFAN ENGIN	ES	
	LEW-10957	COMPUTER PROCRAM FOR CESION POINT PERFORMANCE OF TURBOJET AND TURBOFAN ENGINE SYCLES	e
TU	COJET ENGIN	ES	
		COMPUTER PROCESS FOR CESSES POINT PERFORMANCE OF TWENDIET AND TURBOFAN ENGINE CYCLES JET 1-ANALYSIS OF JET ENCINE BURST-POTER CONTAINMENT DEVICES	:
TU	BOMACHINE &	LADES	
	1EM-10784	VELOCITIES ARC STREAMLINES ON A BLACE-TO-BLADE STREAM SUFFACE OF A TURBOMACHINE MAGNEY-FERTRAN PROGRAM FOR CALCULATING VELOCITIES IN A MAGNIFIED RECION ON A BLADE ID BLADE SJRFACE OF A TURBOMACHINI	:
	LFW-10977	FORTRAM PROGRAM FOR CALCULATING TRANSONIC VELOCITIES OM A DLADE TO BLADE STREAM SUFFACE OF A	4
	L#W-11516	COMPUTER PROGRAMS FOR PREDICTING TURRORAMP INDUCER LOADING, STRESS MAGHITURE, DISTRIBUTION AND	•
	LFW-11635	VIBRATION CHAPACTERISTICS CHAPEL-ECRIPAN PECCAM FOR QUASI-THPEZ-DIPENSIONAL CALCULATION OF SURFACE VILOCITIES AND CHOKING FLOW FOR TURROMACHIRE BLADE ROWS	• •
TUI	BORADEE NERV		
	LEW-00236 LEW-10743	COMPUTER PROCRAM FOR CALCULATING FLOW DISTRIBUTION IN A RADIAL—INFLOW TURBINE FORTRAN PROCRAM FOR CALCULATING VELOCITIES AND STREMFLINES ON A BLADE TO BLADE STREAM SURFACE OF A TANDEM BLACE TURCHACTINE FOR THE STREAM SURFACE OF A TANDEM BLACE TURCHACTINE FOR THE STREAM SURFACE OF A TANDEM BLACE TO THE STREAM SURFACE OF A TANDEM BLACE FOR THE STREAM SURFACE OF THE SURFACE OF THE STREAM SURFACE OF THE SURFACE OF	3
	LEW-10788 LEW-10789	VELUCITIES AND STREAMLINES ON A BLADE-TO-BLAYE STREAM SUMFACE OF A TURODNACHINE MAGNEY-FORTRAN PROGRAM FOR CALCULATING VELOCITIES IN A MAGNIFIE'S REGION ON A BLADE TO BLADE SURFACE OF A TUROPOSACHINE	
	LEW-11029	ANALYSIS OF CECHPTRY AND DESIGN POINT PERFORMANCE OF AXIAL +LC. TUPBINES USING SPECIFIED MERIDIONAL VELOCITY GRACIENTS	4
			61 83
tu	BULENT FLOW		
		FORTRAN FRICEPAMS FOR THE CESIGN OF LIQUID TO LIQUID JET PUMPS COMPUTER PROGRAM FOR CUAST-CME-DIMENSIONAL COMPRESSIBLE FLOW WITH AFEA CHANGE AND FRICTION-APPLICATION TO GAS FILM SEALS	\$0 49

TWO	DIMENS TOWAL	RODIES	`\	
		MASTLAY-REALTE ELEMENT MESH CEMEMATION PROGRAM AUTOTEM-A COMPLIER PRICEMAM FOR AUTOMATED GEOMETRY MESHING AND MEAT CONDUCTION CALCULATION	`	11
THO	DIMENSIONAL	. FLCV		
	LFW-11414	COMPRESSIBLE LAMINAR OR TURNILENT NONSIMILAR ROUNDARY LAYERS COMPUTER PROGRAM NUMERICAL SCENITION OF THE UNSTEADY MAYER-STORES EQUATIONS AND APPLICATION TO FLOW IN A REST CAVITY WITH A POLING HALL	ANGJEAR	41
UMF			· •	
7		LHELP-UNIVERSITY OF HOUSTON EASY LINEAR PROGRAMMING SYSTEM		71
2 Mars	TEADY FLOW			
		NUMERICAL SOLETIFN OF THE UNSEFADY NAVIER-STORES EQUATIONS AND APPLICATION TO FLOW IN & MEST	4 M*1# 4 B	41
		CAVITY WITH A MOVING HALL		
		THERMAL ANALYSIS CE PLUIC FLOW IN A PIPE		*1
URB	AN PLANNING			_
		MAM-RECTAPILITY ANALYSIS PCDEL		* 1
URS	AN TRANSPORT	AT LON	•	
	NPO-13522 -	MORGANIDAN MESS THANSIT STMILATION MODEL		• •
ן דט	LITATION			
	MIS-IA141	SCIENTIFIC MACKETIC TAME LIMMAN SYSTEM LANCIN-LANDRAICMY JON CONTROL PROGRAM COMMUTER UTILIZATION MEETETION MODIL	-	- 40 - 40
VAP	CRT2 ING			
	LAR-11 801	CHEMICAL EQUILIBRIUM IN APLATION MATERIALS, INCLUDING COMPENSED SPECIES		11
VAR	TANCE			
	NPO-11574	CAUSS-PARCEM RUMPER GENERATOR PROCESAM		. 14
V AR	IANCE ESTATE	ISTICSI		
	LFM-1106>	RAPTER-FE LACK TO PROCEAM FOR MIRTIPLE LINEAR REGRESSION ANALYSIS PROVIDING INTERVALLY EVALU-	ATED	61
¥45	P			
	480-10616	VASP-VARIABLE CIPLASICE ANTICHATIC SYNTHESIS PECGRAM		11
VEC	TAN 11			
	M5C-14784	VECTAM 11-CEMPLIER PREGRAM FOR THE ANALYSIS OF VECTOMCARDINGRAMS		14
VFC	TORC AND LOGRA			_
•		VECTAN 11-COPPUTER PROGRAM FOR THE ANALYSIS OF VECTOR CARDIDISTANS		14
***	TORS (MATHER			• :
• 1 0		GAUSS-RANDOP ALWEIR CENTEATER PROGRAM		• •
		And security of a feet for the feet to desire		14
VIC	UC114 TLM-15456	CALCIRATION OF SUPERSONIC STREAM PARAMETERS OF A REAL DAS FROM MEASURABLE QUANTITIES USING C IN ROUTINES	1 R 1 F 8 W	4.8
45 L	CETT DISTRI	IBUTION		
	(fw-11675	CHANEL-FORTHON PRICEAM FOR QUAST-THREE-DIMENSIONAL CALCULATION OF SURFACE VELOCITIES AND THO FLOW FOR TURECPACHERE FLADE ROSE	(145	•
VEL	NCETY MEASU	REMENT		
	1 FW-11415	MINISTICAL SCRIPTICA OF THE UNSTEADY NAVIER-STORES EQUATIONS AND APPLICATION TO FLOW IN A RECT	FASILAR	41
		CAVITY WITH A POSING SALL FORTRAN PAGGRAM FOR CALCULATING VELOCITIES IN THE REPIDIONAL PLANT OF A TURROMACHINE		,
VEN	TILATION			
		SISTP-PREGRAM FOR SCLAP EMERCY MEATING SYSTEMS ANALYSIS		1.
ver				••
		PRACE-A DIGITAL COMPUTER SUBSTITUTION TO ACCELERATE THE CONVERGENCE OF STERATURE PROCESSES		74
y1=	RATION MODE			•
		SHAP OYNAMICS-STRUCTURAL RETURK ANALYSIS PROGRAM		

١.

VIBRATIONAL SP	ECTRA		
148-11570	SNAP DYNAMICS-STRUCTURAL RETWORK ANALYSIS PROGRAM		4,
VIRGATIONAL ST	RESS		
1EH-11214	COMPUTER PROCESUS FOR PRECICTING TUPROPURP INDUCER LOADING VIRRATION CHARACTERISTICS	. STRESS MAGNETUDE, DESTREBUTION APID	•
VICAR			
	VICAR-VINED THACE COMMUNICATION AND RETRIEVAL SYSTEM VICAR-VIDED THACE COMMUNICATION AND RETRIEVAL SYSTEM.		3
WEDED DATA			
G2C-15014	SHIPS-SHALL INTERACTIVE MADE PROCESSING SYSTEM		51
VIEW EFFECTS			
#F \$ -210 75	RAVERC-RADIATION VIEW FACTER PROGRAM		•
VESCOUS FLOW			
45C-17564	SHAC-4 NUMERICAL TECHNIQUE FOR CALCULATING INCOMPRESSIBLE	FLUID FLOWS	•
WESUAL DESPLAY	\$		
000-0001	HIPS-HAT TOWAL PILITARY COMPAND ENFORMATION PROCESSING SYST	EM. SYSTEM 360 FORMATTED FELE SYSTEM	2
VITARINS			
NPO-13206	MITRITIONAL EVALUATION OF CIETS		1
VOATICES.			
144-11047	WHOTEK LATTICE FEPTPAN PROCRAM FOR ESTIMATING SUBSCRIC AFRI	CONTRACTERISTICS OF COMPLEX	
WALL FLOW			
#2C-1270#	MILITUICE-A COMPLETER EMCCHAM THAT MIMERICALLY INTEGRATES TO THE HYDRODYNAMICS OF A LARCE CLASS OF HEAT PIPPS	HE DIFFERENTIAL EQUATIONS THAT DESCRIPE	
WASP			
LFW-12204	WASP-A FLERIBLE FORTRAN BY COMPUTER CODE FOR CALCULATING W	ATER AND STEAM PROPERTIES COM VERSIONS	. •
WATER			
10001-000	STHIRM-SCHROLITHE FOR THE THERMODYNAMIC PROPERTIES OF STEA	M AND MATER	•
MATER BELANCE			
	DUAL 1-SIMULATICS OF WATER CHALLY IN STREAMS AND CANALS DUSAG 1-SIPULATION OF WATER QUALITY IN STREAMS AND CANALS		• 5
MATER ECHSUMPT	EON		
MF 5-71 **7	METANTLEC RALANCE ANALYSIS PROGRAM		ı
MATER FLOW			
	DIAL 1-SIMILATION OF WATER QUALITY IN STREAMS AND CANALS		3
MEELE FRAUERC			
#L <-\$1 d+4	RAL W-WATER THEACT LOADS		•
WATER POLLUTED	The control of the co		
	DUAL 1-SIMULATION OF MATER DIBLITY IN STREAMS AND CANALS DUSAGE 1-SIMULATION OF MATER DUBLITY IN STREAMS AND CANALS	*	,
-	URE		
	DIGGO E-SIMPLATION OF MATER QUALITY IN STREAMS AND CANALS		5
MAYE FROMTS			
MPO-13322	MANALAGERIA ELLER CATERINEZZ MELLIF MANE EBLINA BEZEDNEME	IAC babbram	•
MAYEFORMS			
446-1-120	VECTAN 11-CONFLITER PACCHAM FOR THE ANALYSES OF VICTORCARDS	TCRAWS	ı
MAVEFRONT			
MPO-13322	MANEFRONT-STREETERS STEEFESS MATRIE WAVE FRONT RESERVENCE	ING PRAGRAM	

MESCHT (MESS)		
	FRAP-PRESSURIZED STRUCTURE CRITICIZATION OPTIMIZATION OF FLUID LIKE SIZES WITH PUMPING DOWER PENALTY	86
WICKS		
696-1-309	MILTINICA-A COMPUTER PROCESH THAT NUMERICALLY INTEGRATES THE DIFFERENTIAL EQUATIONS THAT DESCRIBE THE MYDRODYNAPICS OF F LARCE CLASS OF HEAT PIPES	41
MIDE ANGLE LEM	stes .	
[AR-11873	CONVERT-RECHARCUE AND COPPLIER PROGRAM FOR CALCULATING PHOTOGRAPHIC FILM DENSITY VARIATIONS	54
WIND EFFTEORDL	CCT 1	
490-11847	ATRPOL-MIND TRAJECTORY TEACING FOR ATR POLLUTION STUDIES	- 53
MINO DIRECTION		٠.
450-10425	SSCOI-STATISTICAL SEMBARY OF CELHATOLOGICAL DATA	52
MIND AEFUCILA		
KSL-10425	SSC 31-STATESTECAL SUPPARY OF CLEMATOLOGICAL DATA	
WING LOADING		
	MODIFIED METHOPP SUBSONIC LIFTING SUPFACE METHOD OF AFRI CHARACTERISTICS. SUBSONIC ANNULAR WING THEORY WITH APPLICATION TO HERW ABOUT NACELLES.	
WENG PLANFORES		•
7	VORTER LATTICE FORTRAN FROCRAM FOR ESTIMATING SUBSONIC AFRODYMAMIC CHARACTERISTICS OF ECMPLER PLANFORMS MODIFIED MULTHOPP SUBSORIE LIFTING SUBFACE METHOD OF AFRO CHARACTERISTICS	. 1
WINGS	with the afternation of the time of the time of the second the sec	•
	SURSONIC ANNULAR WING THEORY WITH APPLICATION TO FLOW ARRUIT NACELLES	,
WIRE BRIDGE CI		
	WIRE CHAIN PERGRAM, UNIVAC 1108 VERSION	35
WIRE WINDING	mint tout a territory out into the standing	
	AUTONIRE CIRM SEC VERSICES	
WIRING	author fine to the first	
	AND THE SAME AND	•
	AUTOMIRE SIRM 36C VERSIONI COMPUTERIZEC TECHNIQUE FOR DICUMENTING COMPLEX MIRING	\$3
ZERO ANGLE OF	ATTACK	
LAR-11727	SUBSONIC ANNILAR WING THICHY WITH APPLICATION TO FLOW AROUT MACELLES	



JAN 9 1981

End of Document